TEMPLATE

SHORELINE COUNTERMEASURES MANUAL

TROPICAL COASTAL ENVIRONMENTS

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
HAZARDOUS MATERIALS
RESPONSE & ASSESSMENT
DIVISION

MAY 1993

SHORELINE COUNTERMEASURES MANUAL

TROPICAL COASTAL ENVIRONMENTS

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

HAZARDOUS MATERIALS
RESPONSE & ASSESSMENT
DIVISION

MAY 1992

Contents

Contents, cont.

Contents, cont.

Introduction

Shoreline countermeasures following an oil spill are a critical element in determining the ultimate environmental impact and cost resulting from a spill. As with most aspects of spill response, careful planning can significantly increase the effectiveness of treatment operations. Local response organizations need to develop mechanisms for identifying shorelines requiring treatment, establishing treatment priorities, monitoring the effectiveness and impacts of treatment, and for identifying and resolving problems as the treatment progresses.

The National Oceanic and Atmospheric Administration (NOAA) developed this manual as a tool for shoreline countermeasure planning and response by Regional Response Teams, Area Planning Committees, and State and local response agencies. This manual has been written specifically for tropical environments, to support oil spill planning and response activities in both the Caribbean Sea and the Pacific Ocean regions. Similar manuals have been prepared for temperate regions, and a freshwater manual is under preparation.

Even though this manual has been adapted for tropical environments, further customization for each geographic area is needed and encouraged. Each section of the manual should be adapted to address specific issues, priorities, and concerns in the planning area. These elements provide the information needed to select cleanup methods for specific combinations of shoreline and oil types. Adapting and completing the various sections creates a better manual that meets the specific needs of the area. More importantly, the pre-spill process of adapting this manual should allow response agencies the opportunity to discuss and resolve shoreline treatment issues prior to a spill emergency.

The shoreline environments have already been revised to reflect those found in tropical areas, based on those included in the Environmental Sensitivity Index (ESI) atlases prepared by NOAA for Florida, Puerto Rico, U.S. Virgin Islands, Hawaii, and Guam. The shoreline descriptions and rankings in these atlases descriptions have been updated to reflect the current research on oil behavior and response activities, and they are discussed in Chapter 2. The section on Special Considerations at the end of Chapter 2 lists those resource issues that are potentially of concern in tropical environments. Guidelines have been written for three types of special concerns common to all tropical regions: coral reefs, seagrasses, and turtle nesting beaches. It is intended that each region or area would identify those resources

of greatest concern to them and prepare similar guidance on how to best minimize impacts from oil spills.

Chapter 3 of the manual also outlines a process of documenting and recommending cleanup options for a section of a shoreline after it has been oiled. The scope of the process should be scaled to fit the spill size and conditions. Thus, both comprehensive and simplified forms and methods have been included.

Chapter 4 contains the main thrust of the manual, the matrices for recommended cleanup methods for four main types of oil and the shoreline habitats present in tropical environments. Each region should complete the matrices for themselves.

Chapters 5 and 6 include detailed descriptions of the various shoreline treatment methods to be considered. Local experts in shoreline treatment should be involved in the analysis of the effectiveness and effects of each of these methods for each area.

The appendices include a section on Best Management Practices, which have been compiled from previous spills. These practices address specific resource issues which were raised during an oil spill and resolved by the scientific community. They are included as examples for response teams to follow, in the event similar issues arise. Each region is encouraged to contribute to this appendix additional practices as they are developed during actual spills, so that all may benefit from the lessons learned.

1 Decision Process Organization

A Shoreline Evaluation Process

The shoreline evaluation process requires a commitment of trained personnel to assess, evaluate, and communicate the effects of oil on the shoreline, as well as to recommend countermeasures to mitigate adverse effects. At most spills, a repetitive, detailed, and systematic survey of the extent and degree of shoreline contamination is needed to:

1. Assess the need for shoreline cleanup
2. Select the most appropriate cleanup method
3. Determine priorities for shoreline cleanup
4. Document the spatial oil distribution over time
5. Maintain an internally consistent historical record of shoreline oil distribution for use by other scientific surveys of intertidal and subtidal impacts

The organizational structure described in the following pages details a three-phase model for the On-Scene Coordinator (OSC) to use in establishing the shoreline evaluation process during an incident. During a small spill event, one team of individuals may be able to conduct all three phases of support.

On the other end of the spectrum, during a larger spill event, three or more separate teams would be required to conduct all three phases of support to the OSC. The products of the shoreline evaluation process for a larger spill would include collecting the individual shoreline sketches noting the extent of oiling, developing a database either in text matrix or graphics displaying the oil distribution on the shoreline, recording the decision process from the initial assessment of oiling, and monitoring and final evaluation of the countermeasures used.

1 Shoreline Assessment Group

Objectives

To determine location and extent of shoreline oiling, and effectiveness of implemented countermeasures.

Members

Three or four trained personnel prepared to evaluate a section of shoreline, equipped with proper protective gear and suitable transportation to and from the site. The assessment group should have representatives of the OSC, State, responsible party, and trustees. Trained volunteers may assist members of the group. Team members must have basic site safety training and training sufficient to complete the Shoreline Survey Evaluation Form (page 33). A person well-versed in oil spill control should be the team leader. The group leader should seek consensus, however, all areas of controversy or differences of opinion shall be documented and forwarded to the OSC. Specific recommendations for cleanup may be included under this phase of the assessment. Chapter 3 outlines the shoreline field evaluation process.

Products

During a small spill event, the products may be as simple as a field sketch illustrating the oil distribution on the impacted shoreline and photographic documentation. During more complex events, the completion of the Shoreline Survey Evaluation Form would be required to document the many details of the oil's distribution on complex shoreline features.

2 Shoreline Product Review Group

Objectives

Assure product quality of the Shoreline Assessment Group. Assure quality of the spill database.

During larger or complex spill events, the OSC may elect to establish a special quality assurance / quality control (QA / QC) team. The responsibility of this group is to insure that information from the Shoreline Assessment Group is accurate and consistently gathered. They will assure items of significance that may have been overlooked by the Shoreline Assessment Group are added to the assessment process from other data sources (i.e., in-house reports, maps, databases) such as culturally or archaeologically significant areas.

Significantly, the time-sensitive elements of the response may also be added to recommendations to the OSC by this team. For example, are there natural resources that are particularly sensitive to oiling at the time, or season, the spill is occurring? Is there a window of opportunity to conduct countermeasure operations to protect a turtle nesting season (remove the oil before they arrive) or terminate countermeasure activities to protect bird nesting areas (keep the responders away from nesting areas with live chicks)?

Members

The Shoreline Product Review Group should contain representatives from the OSC, State, land managers, and database managers, as appropriate. The State representative shall collect and forward special concerns submitted by local authorities. The NOAA Scientific Support Coordinator (SSC) team can assist in the design of the database to compile detailed data on oil distribution by shoreline segment.

Products

During more complex spill events, a database will be used to collect and summarize the Shoreline Evaluation Survey forms prepared by the field teams. The use of maps and other graphics to display the oil's distribution on the shoreline is critical in assisting the decision process. This display may be as simple as using colored markers on existing maps or charts. There should not be a requirement for a computer-generated display of the oil's distribution on the shoreline when lower technology displays will provide the same information to the Technical Advisory Group and the OSC. The NOAA SSC team can assist in the design of a visual display for a particular spill event by drawing pictures representing oil distribution on representations of particular shorelines now available from National Ocean Survey (NOS) charts.

For more detailed statistical documentation, the use of a database to collect and summarize distances and extent of shoreline segments that are oiled may also be required. There should not be a requirement for the computer system to be both a combination of a visual and a data collection system when lower technology systems can provide the same information to the Technical Advisory Group and the OSC.

3 Technical Advisory Group

Objectives

Review and evaluate Shoreline Survey Evaluation forms to provide timely advice to the OSC for recommended treatment of oiled shorelines and priorities, including specific countermeasures. In addition, this group will consider the effects of proposed countermeasures. They may also suggest alternative or modified countermeasures and technologies to the OSC for experimental trials during a spill of opportunity.

Members

NOAA SSC, State representative, trustee(s), U.S. Coast Guard, and responsible party. The SSC will present group recommendations, including differing opinions, to the OSC. Participants in this group shall have the authority to commit their agencies to recommended actions. The level of staff participating on this team should have the authority to determine the final recommendations.

Products

One key product of the Technical Advisory Group is feedback to the Shoreline Assessment Group on treatment countermeasures that have been approved. The Shoreline Assessment Group will then be able to assess the effectiveness of this treatment method on the affected shoreline and make recommendations back through the Technical Advisory Group for any adjustments necessary to improve the efficacy of the cleanup. The form of the feedback may be as simple as a copy of the approved countermeasure or a work order. The copying of the graphics/charts, in which the oil distribution is displayed, would be another desirable form of feedback. Recommendations and authorized countermeasures should be copied to each team member.

B Termination of Countermeasure Activities

Objective

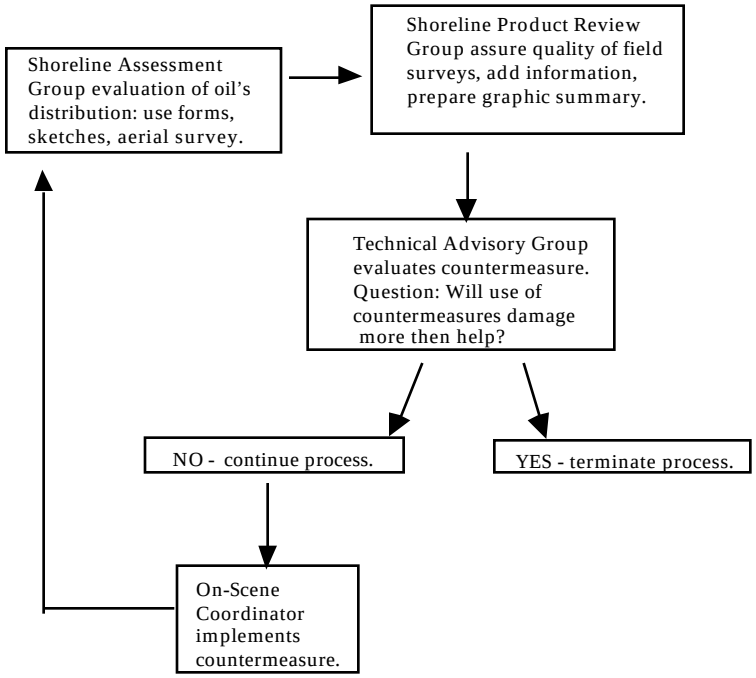
To reach agreement on the completion of each shoreline segment countermeasure activity.

Product

Completion of active shoreline countermeasures under the jurisdiction of the Federal Government is a decision of the OSC. Support of the OSC requires recommendations on shoreline countermeasures, and also recommendations on when to terminate response. The process of evaluating the results of countermeasures and the recommendation to terminate response activities requires a give and take of members with many different responsibilities and roles. A goal of the Technical Advisory Group is to determine if the continued use of a particular countermeasure will result in more damage to the environment than would occur as a result of terminating any active response measures.

Summary of the Decision Process

This section outlines the cyclical decision tree for evaluating activities.



Summary products of the decision process, including the use of maps and other graphics to display the oil's distribution on the shoreline, is critical in assisting this cyclical decision process.

- This display may be as simple as using colored markers on existing maps or charts.
- For more detailed and statistical documentation, the use of a database to collect and summarize distances of shoreline segments that are, for example, heavily or lightly oiled, may also be required.
- The NOAA SSC team can present the visual and database information, including differing opinions of members, to the OSC.
- This report of the recommendations and countermeasures approved for use should be copied to each team member and collected for inclusion in the final OSC report as required.

2 Shoreline Types and Sensitive Resources

The type of shoreline, degree of exposure to waves and currents, and associated biological sensitivity are the main criteria for selecting appropriate treatment techniques. Prediction of the behavior and persistence of oil on intertidal habitats is based on an understanding of the coastal environment, not just the substrate type and grain size. The vulnerability of a particular intertidal habitat is an integration of the:

1. Shoreline type (substrate, grain size, tidal elevation, origin)
2. Exposure to wave and tidal energy
3. Biological productivity and sensitivity
4. Ease of cleanup

All of these factors are used to determine the relative sensitivity of shorelines. Key to the sensitivity ranking is an understanding of the relationships between: physical processes, substrate, shoreline type, product type, sediment transport, and product fate and effect. The intensity of energy expended upon a shoreline by wave action, tidal currents, and river currents directly affects the persistence of stranded oil. The need for shoreline cleanup activities is determined, in part, by the lack or slowness of natural processes in removal of oil stranded on the shoreline.

These concepts were used in the development of the Environmental Sensitivity Index (ESI), which ranks shoreline environments as to their relative sensitivity to oil spills, potential biological injury, and ease of cleanup. Generally speaking, areas exposed to high levels of physical energy, such as wave action and tidal currents, and low biological activity rank low on the scale, while sheltered areas with associated high biological activity have the highest ranking. The shoreline ranking system provides a useful first step in the design of contingency plans because it identifies the priority areas that require maximum effort for protection and cleanup. The shoreline types used in this manual are the rankings, on a scale of 1 to 10, used on ESI maps prepared for Florida, Puerto Rico, U.S. Virgin Islands, Hawaii, and Guam The descriptions, predicted oil impact, and recommended response activity listed in the following sections were updated from existing ESI maps, based on NOAA (1992). These shoreline types are then used in the matrices in Chapter 4.

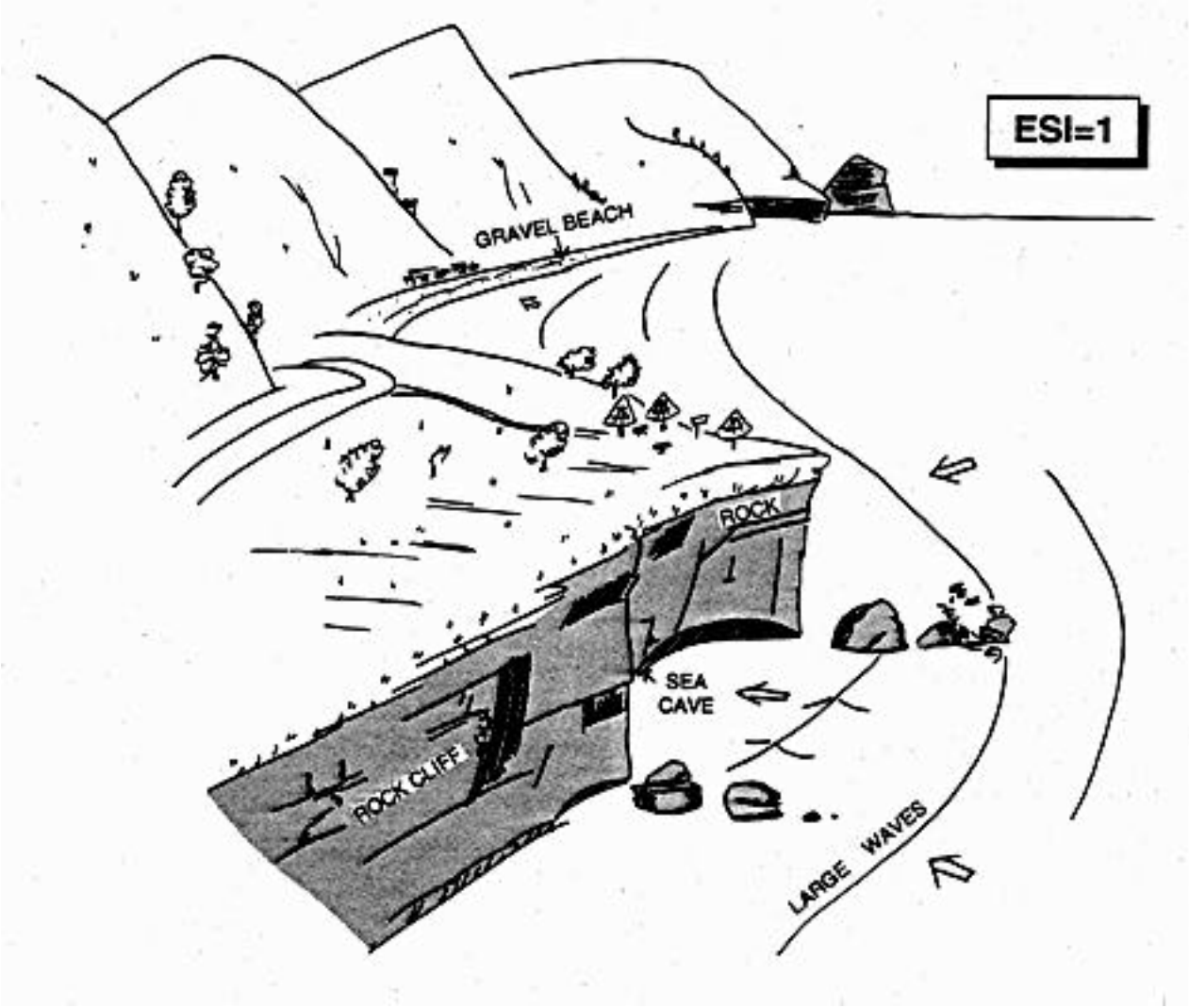
ESI=1 Exposed Rocky Shores and Vertical, Hard Man-Made Structures (e.g., Seawalls)

Description

- Exposed rocky shores are composed of vertical scarps (>45° in slope) in bedrock.
- They are most common on exposed headlands with steep nearshore topography.
- They are exposed to high wave energy or tidal energy on a regular basis.
- In places, the vertical scarps are buttressed at the base by large slump blocks.
- Seawalls and piers occur in developed areas to provide protection to residential and industrial developments.
- Substrate may be colonized by intertidal algae and limpets, although attached organisms are usually sparse to moderate.

Predicted Oil Impact

- Most commonly, oil would be held offshore by waves reflecting off the steep rock faces.
- Deposited light oils would be removed rapidly by wave action; heavier, sticky oils are likely to remain longer as a patchy band at or above the high-tide line.
- Heavy and weathered oils would adhere to rough surfaces and in crevices; there is little potential for penetration.
- Effects on intertidal communities are expected to be of short duration; an exception would be where heavy concentrations of a light refined product (e.g., No. 2 fuel oil) came ashore very quickly.



Recommended Response Activity

- On very exposed shores, no cleanup is necessary (and may be dangerous).
- On less exposed shores:
  - High-pressure spraying may be effective while oil is still liquid.
  - Manual scraping of seawalls may be necessary for removal of tarry deposits, to minimize aesthetic impacts.

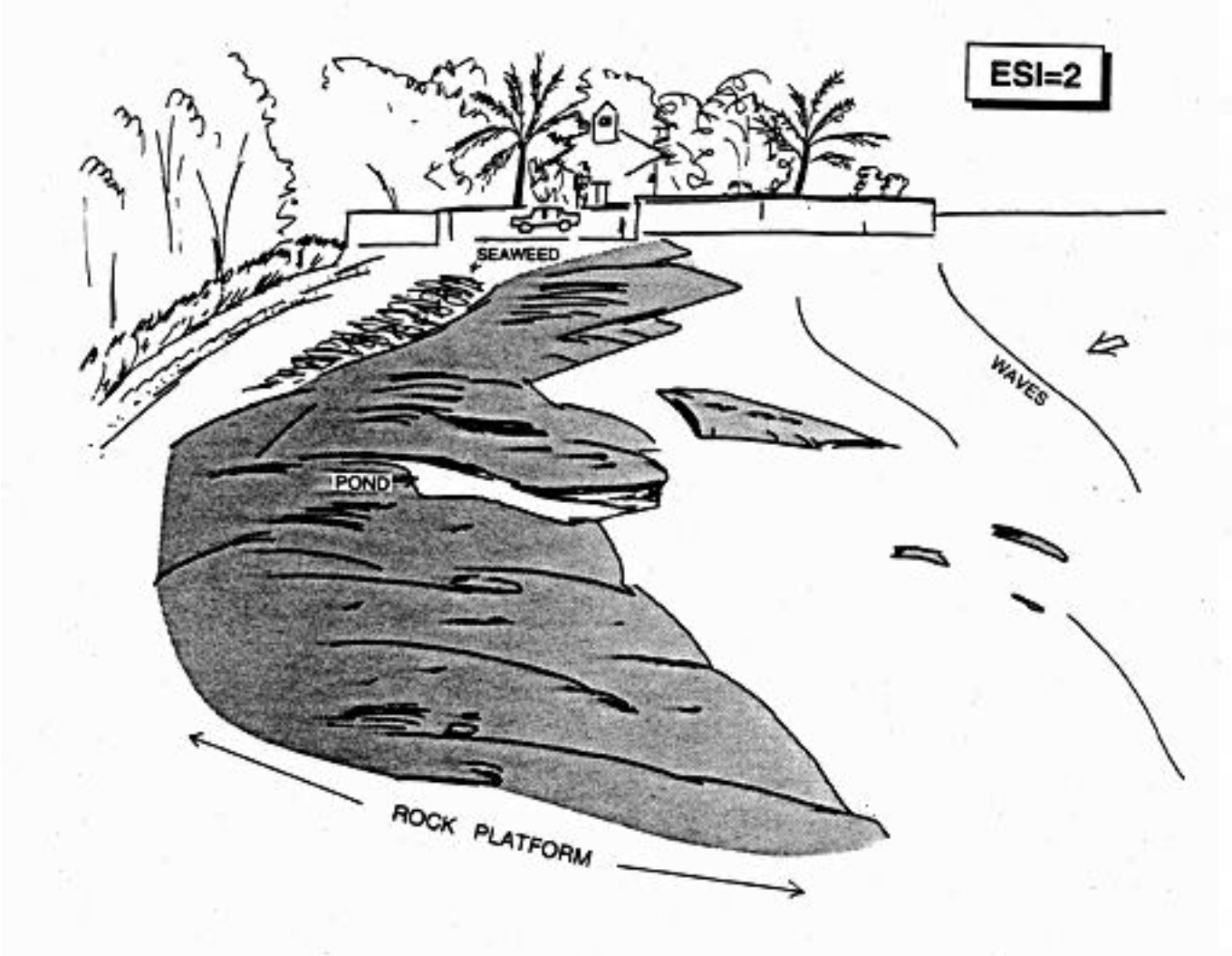
ESI=2 Exposed, Wave-Cut Rock Platforms

Description

- Platforms are wave-cut or low-lying benches in rock, generally exposed to high wave action.
- The platform may be covered by a thin veneer of sand and gravel, frequently colonized by intertidal algae and limpets.
- Rock surfaces are irregular, with numerous tidal pools and associated organisms. The rock surface may be colonized by intertidal algae and limpets.
- In places, low-lying, pitted, and pinnacled limestone merges into offshore reef-flat platforms.
- The reef-flat platform supports large populations of encrusting plants and animals. Often, the heaviest growth on the reef-flat platform is restricted to low-tide moats or where holes and depressions retain water during low tide.

Predicted Oil Impact

- Oil would not adhere to the rock platform, but rather be transported across the platform and accumulate along the high-tide line.
- Light oils may penetrate porous volcanic rocks at the high-tide line.
- Oil can penetrate and persist in the beach sediments on the landward side of the platform, if present.
- Light oils would tend to be removed rapidly by waves and evaporation.
- Heavy oils and tar balls would tend to melt into crevices and depressions, especially on porous, irregular rock surfaces.
- Persistence may be from days to months, depending on the site-specific, wave-energy levels and type of oil.
- Tidal pool organisms and algae may be killed, but recovery can be rapid.



Recommended Response Activity

- Cleanup is not necessary in most areas, except for removal of oiled wrack and accumulated pooled oil.
- High recreational-use areas may be cleaned effectively using high-pressure water spraying of non-vegetated areas if oil is still fresh.
- Avoid removal of organisms.
- Low-pressure flushing may be appropriate on vegetated areas that continue to sheen after several days.

ESI=3 Fine-Grained Sand Beaches

Description

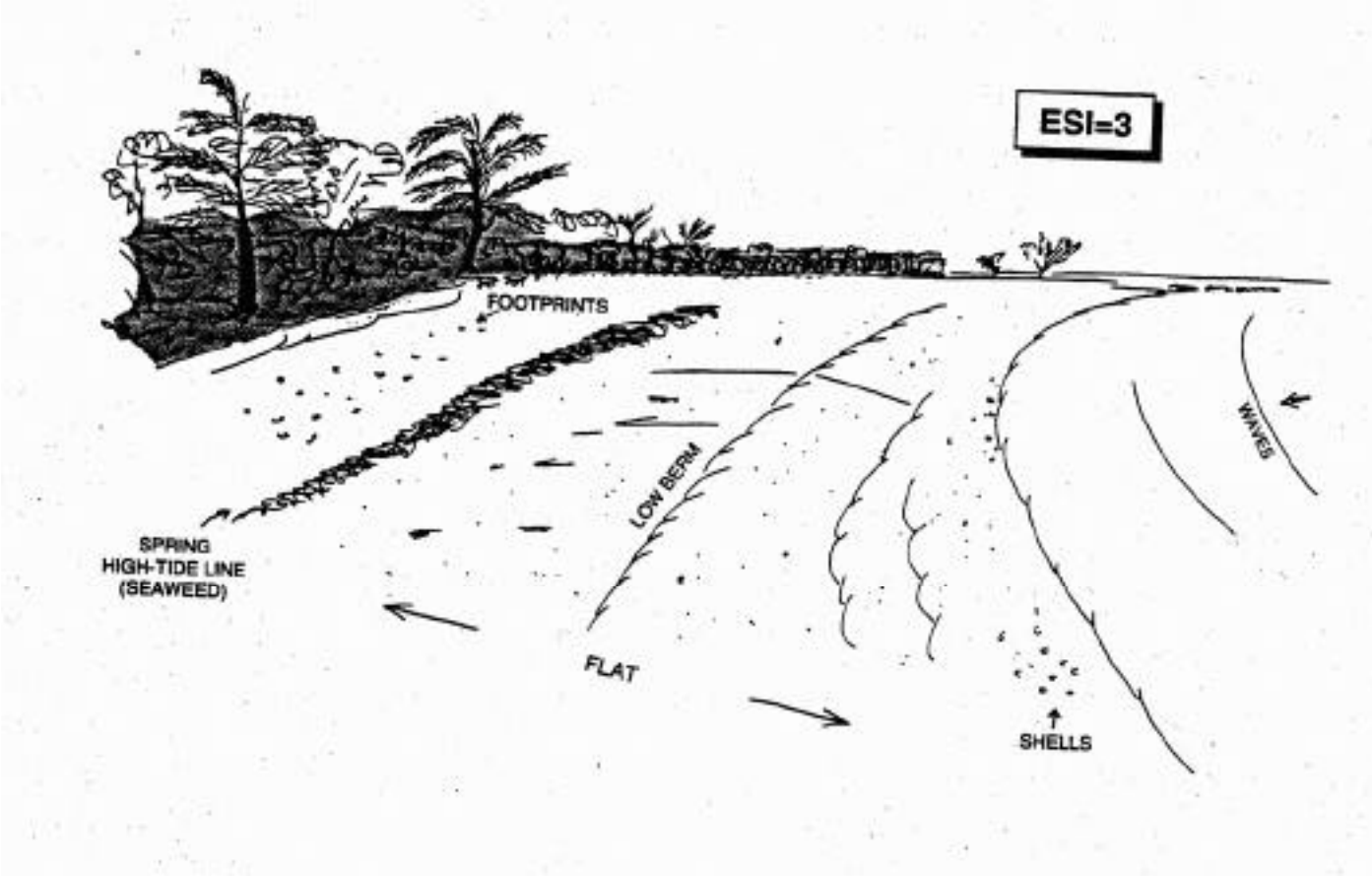
- Not a dominant beach type because of the abundance of coarse shells and coral rubble.
- On islands they are usually found as pocket beaches bordered by rocky headlands.
- They are high-use recreational areas.
- The beaches are generally flat and hard-packed, and infauna are scarce.

Predicted Oil Impact

- Large oil accumulations would cover entire active beach face.
- Light oil accumulations would be deposited as oily swashes along the upper intertidal zone.
- Oil would accumulate in any wrack that may be present.
- Penetration of oil into the beach can be up to 10 cm; burial would be minimal.
- Asphalt pavements can form under heavy accumulations; pavements change the nature and stability of the substrate and thus its biological utilization.
- Shorebirds resting / feeding on these beaches may be oiled.
- Biological effects include temporary declines in beach organisms, which may also affect feeding shorebirds.

Recommended Response Activity

- Fine-grained sand beaches are the easiest beach type to clean.
- Cleanup should concentrate on removal of oil and oiled wrack.
- Sand removal should be minimized to avoid erosional problems; sediment removal activities should commence only after all the oil has come ashore.
- Manual cleanup, rather than use of road graders and front-end loaders, is advised to minimize volume of sand removed and prevent grinding the oil deeper, depending on the size of the oiled area.
- Techniques which wash oiled sand into the lower intertidal and subtidal should be avoided.


ESI=3
FOOTPRINTS
WAVES
LOW BERM
SPRING
HIGH-TIDE LINE
(SEAWEED)
FLAT
SHELLS

ESI=4 Medium- to Coarse-Grained Sand Beaches

Description

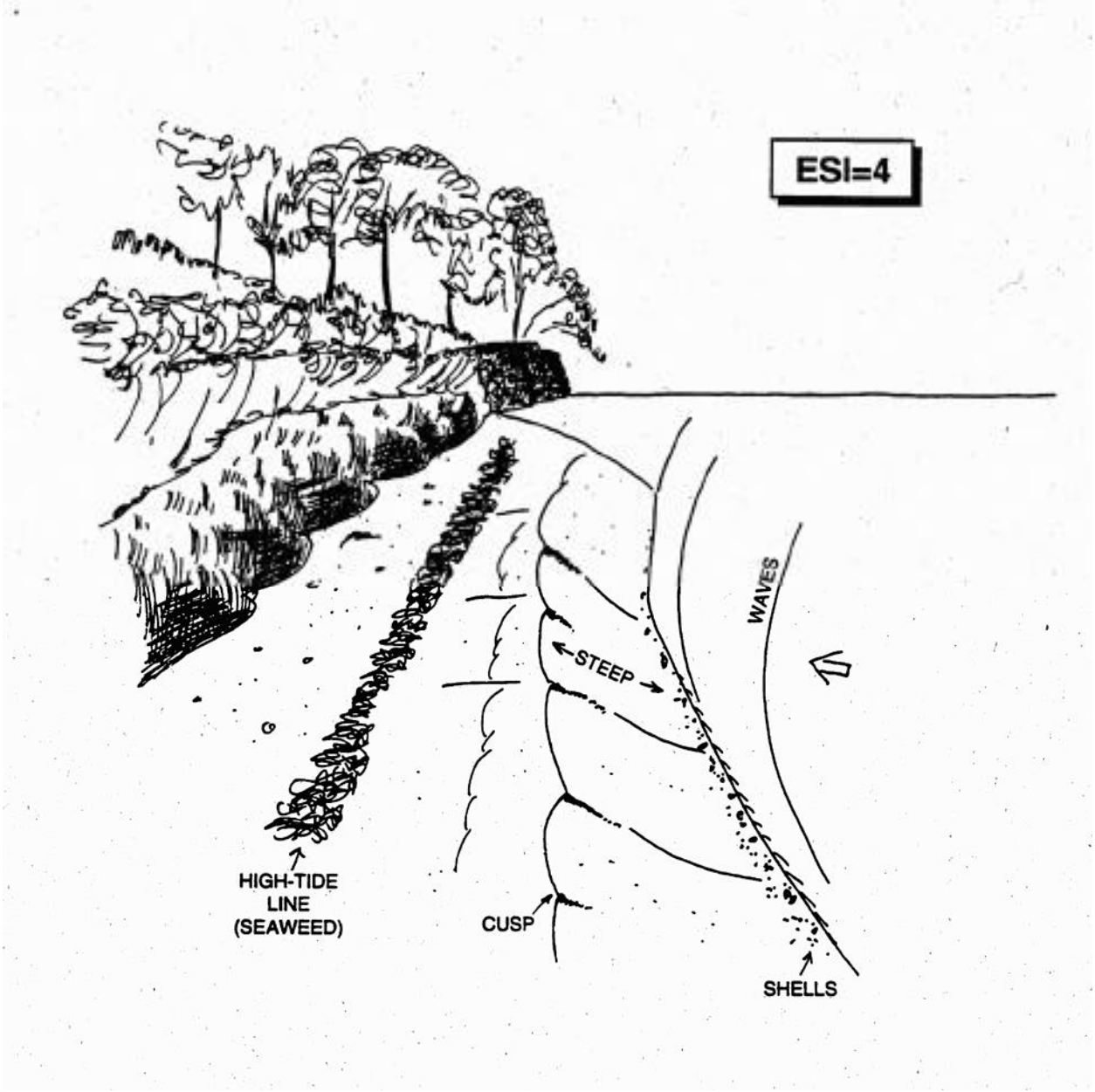
- These beaches are present in areas sheltered by barrier reefs or wide reef-flat platforms, as pocket beaches bordered by rocky headlands, or as long stretches that have been renourished.
- They have moderate beach slopes and are narrow with soft sediments.
- They occur in areas with intermittent high waves and wrack can be common.
- Species density and diversity is usually low.

Predicted Oil Impact

- Under heavy accumulations, oil can cover the entire beach face, although the oil would be lifted off the lower part of the beach with the rising tide.
- Small accumulations would be deposited in swash lines and wrack deposits.
- Large amounts of oil can accumulate behind the high-tide berm, where it is unable to drain off the beach at low tide.
- Oil can penetrate 10-25 cm, with light oils penetrating deeper than heavy oils.
- Oil may become deeply buried (30-60 cm) as clean beach sediments are deposited on top of the oiled layer.
- Asphalt pavements can form under heavy accumulations in more sheltered areas; pavements change the nature and stability of the substrate and thus its biological utilization.
- Temporary declines in infaunal populations may occur.

Recommended Response Activity

- Cleanup may be difficult because of relatively soft sediments (e.g., vehicular access may be impaired).
- Cleanup should focus on oil/oily debris removal from the upper beach face.
- Sand removal should be minimized to avoid erosional problems; sediment removal activities should commence only after all the oil has come ashore.



- Traffic should be limited to prevent mixing oil deeper into the sediments.
- Use of heavy equipment for oiled sand removal may result in the removal of excessive amounts of sand; manual cleanup may be less disruptive, depending on the size of the oiled area.
- Nutrient addition may be an option, particularly when other cleanup methods have reached their practical limit of application. Effectiveness of nutrients would have to be evaluated on a case-by-case basis.

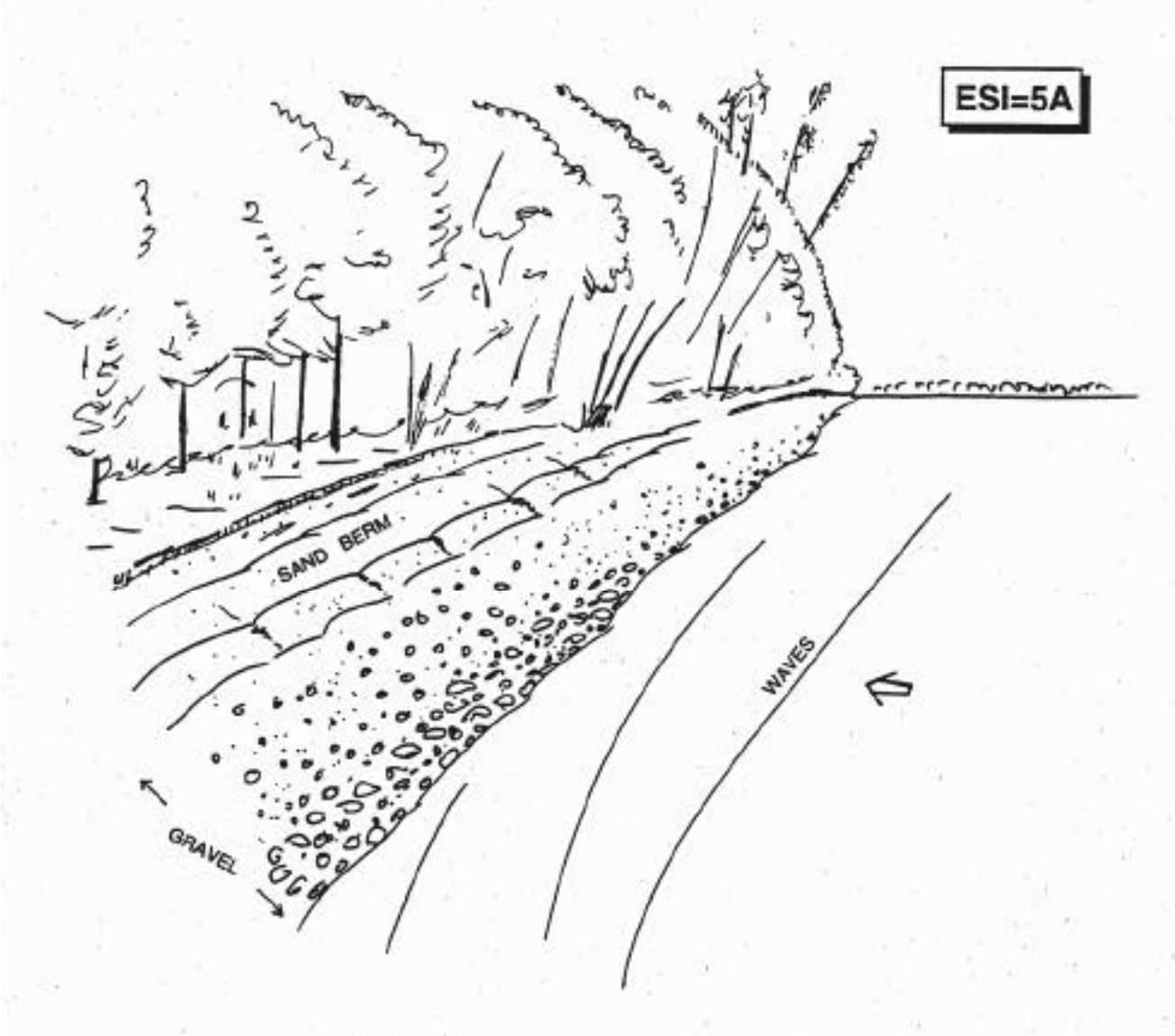
ESI=5A Mixed Sand and Gravel Beaches

Description

- These beaches are composed of a variable mixture of carbonate sand, shells, coral rubble, and rock fragments.
- They occur in a wide variety of settings, but are most common on exposed shorelines in shallow indentions adjacent to eroding headlands and on top of reef-flat platforms.
- Active beaches have low infaunal densities because of sediment mobility; more stable beaches have moderate densities.

Predicted Oil Impact

- Oil penetration may be high (tens of cm), with greatest penetration in coarser, well-sorted sediments.
- Under very heavy accumulations, oil may spread across the entire beach.
- During small spills, oil would be deposited along and above the high-tide swash line.
- Burial of oil by clean sediments may be very deep (more than 1 m) at the high-tide berm.
- Oil can be stranded on low-tide terraces composed of gravel, particularly if the oil is weathered or emulsified.
- Asphalt pavements are likely to form in more sheltered beaches where heavy accumulations of oil fill the voids between the sediments; once formed, these pavements are very stable and can persist for many years.
- Any oil stranded above the high-tide line would be highly persistent.
- Biota present may be killed by the oil, either by smothering or by lethal concentrations of dissolved components in interstitial water.



Recommended Response Activity

- Sediment removal should be minimized to avoid erosional problems; sediment cleanup should commence only after all the oil has come ashore.
- Oiled wrack and debris deposits should be removed manually.
- Low-pressure spraying may be used effectively on coarser-grained beaches.
- Berm relocation is effective for speeding natural removal of subsurface oil.
- Nutrient addition may be an option, particularly when other cleanup methods have reached their practical limit of application. Effectiveness of nutrients would have to be evaluated on a case-by-case basis.

ESI=5B Artificial Fill Containing a Range of Grain Size and Materials

Description

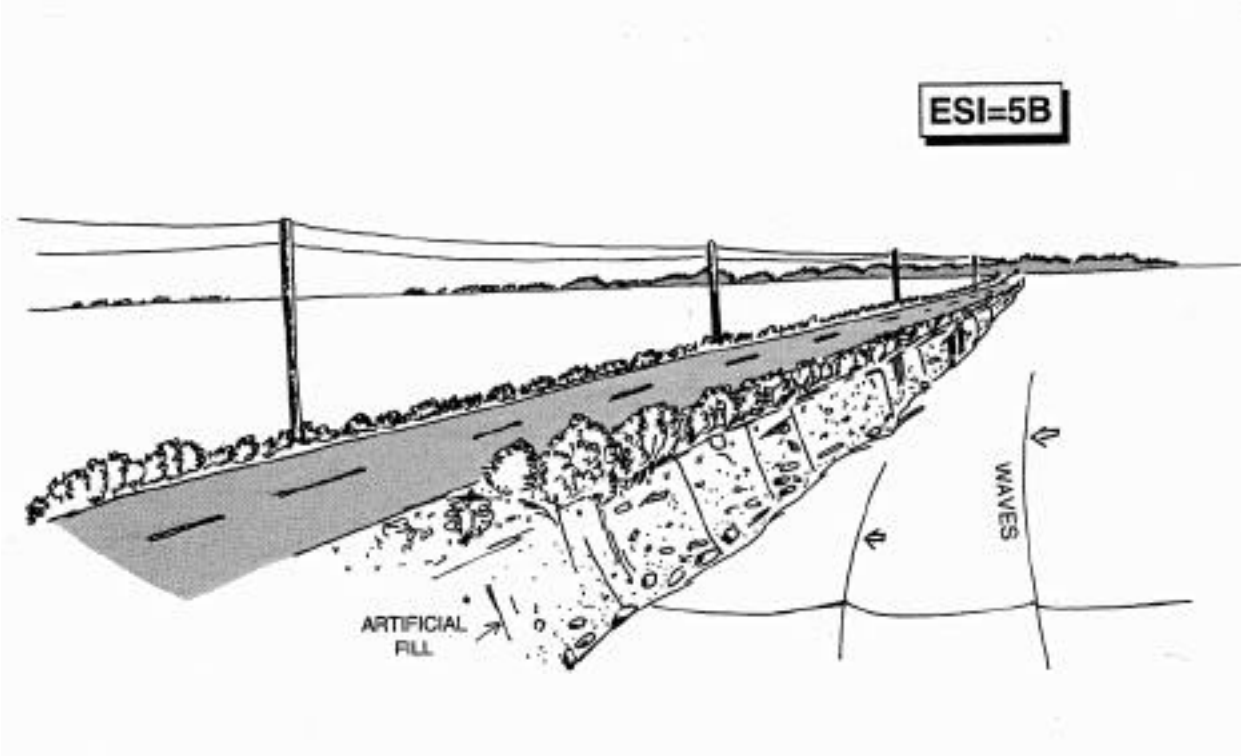
- Most of the developed ports and harbors have areas that have been modified by creating beaches, assorted breakwaters, etc., by artificial placement of a variety of materials.
- Usually has the consistency of mixed sand and gravel beaches, being composed of sand mixed with coral and rock debris.
- These beaches may be exposed only to very intermittent wave energy.

Predicted Oil Impact

- Oil penetration may be high (tens of cm), with greatest penetration in coarser, well-sorted sediments.
- Deeply penetrated oil may leach for a period of time, generating a source of chronic oiling to adjacent habitats.
- Under very heavy accumulations, oil may spread across the entire beach.
- During small spills, oil would be deposited along and above the high-tide swash line.
- Natural removal rates may be very slow, depending on the local wave or boat wake energy.
- Asphalt pavements are likely to form in more sheltered beaches where heavy accumulations of oil fill the voids between the sediments; once formed, these pavements are very stable and can persist for many years.
- Any oil stranded above the high-tide line would be highly persistent.

Recommended Response Activity

- Oiled wrack and debris deposits should be removed manually.
- Low-pressure spraying may be used effectively.
- Removal of sediment may be advisable if more fill is available to replace it, to control chronic leaching or remove pavements.


ESI=5B
WAVES
ARTIFICIAL
FILL

ESI=6A Gravel Beaches

Description

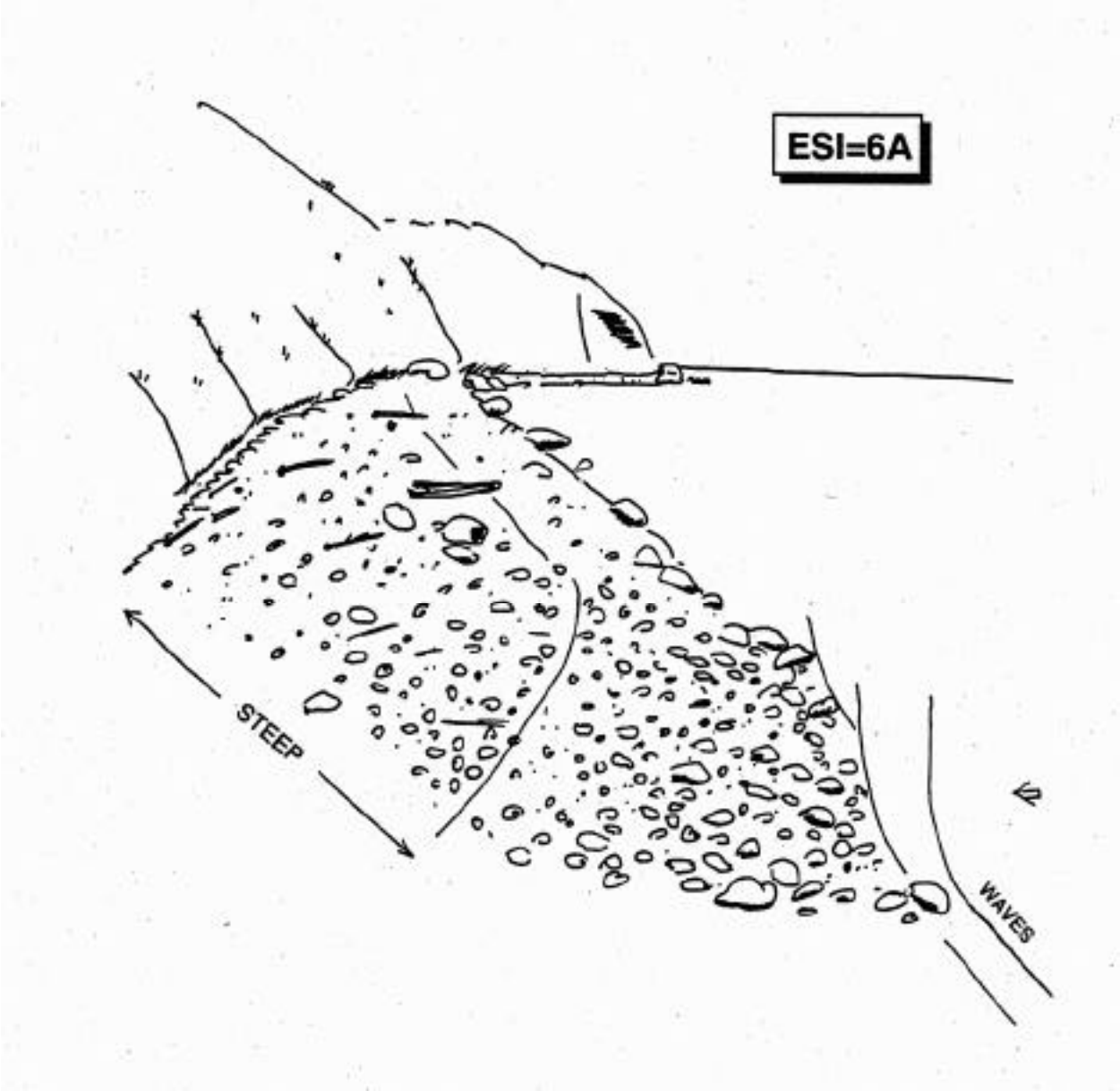
- Gravel beaches are composed purely of gravel-sized sediments, with little-to-no sand.
- The gravel-sized sediments include coral rubble and/or shell and rock fragments.
- Gravel beaches are present adjacent to eroding headlands.
- They can be steep, with multiple wave-built berms forming the upper beach.

Predicted Oil Impact

- Oil on gravel beaches would coat individual pieces of gravel.
- Coral rubble is very porous and most oils will soak into the coral rubble itself.
- High porosity and permeability would allow deep penetration to several tens of centimeters into substrate.
- Penetration would be greatest in areas of largest grain size and best sorting.
- In exposed areas, waves would remove surface contamination.
- In intermittent-energy areas, buried or penetrated oil would tend to seep out slowly, generating sheens that can recontaminate the shoreline.
- There is a high potential for oil burial by accretional features.
- If left to harden, heavy accumulations of oil would likely form an asphalt/gravel pavement in sheltered areas.

Recommended Response Activity

- Heavily oiled wrack and debris should be removed.
- Removal of sediments is not recommended because of the slow rate of natural replacement of gravel.
- High-pressure spraying of oiled gravel may help in cleaning exposed surfaces, but would have little effect on oil that penetrated deeply into gravel.
- Berm relocation is effective for speeding natural removal of subsurface oil.
- Nutrient addition may be an option for treating oiled gravel beaches, particularly when other cleanup methods have reached their practical limit of application. Effectiveness of nutrients would have to be evaluated on a case-by-case basis.


ESI=6A
STEEP
WAVES

ESI=6B Exposed Riprap

Description

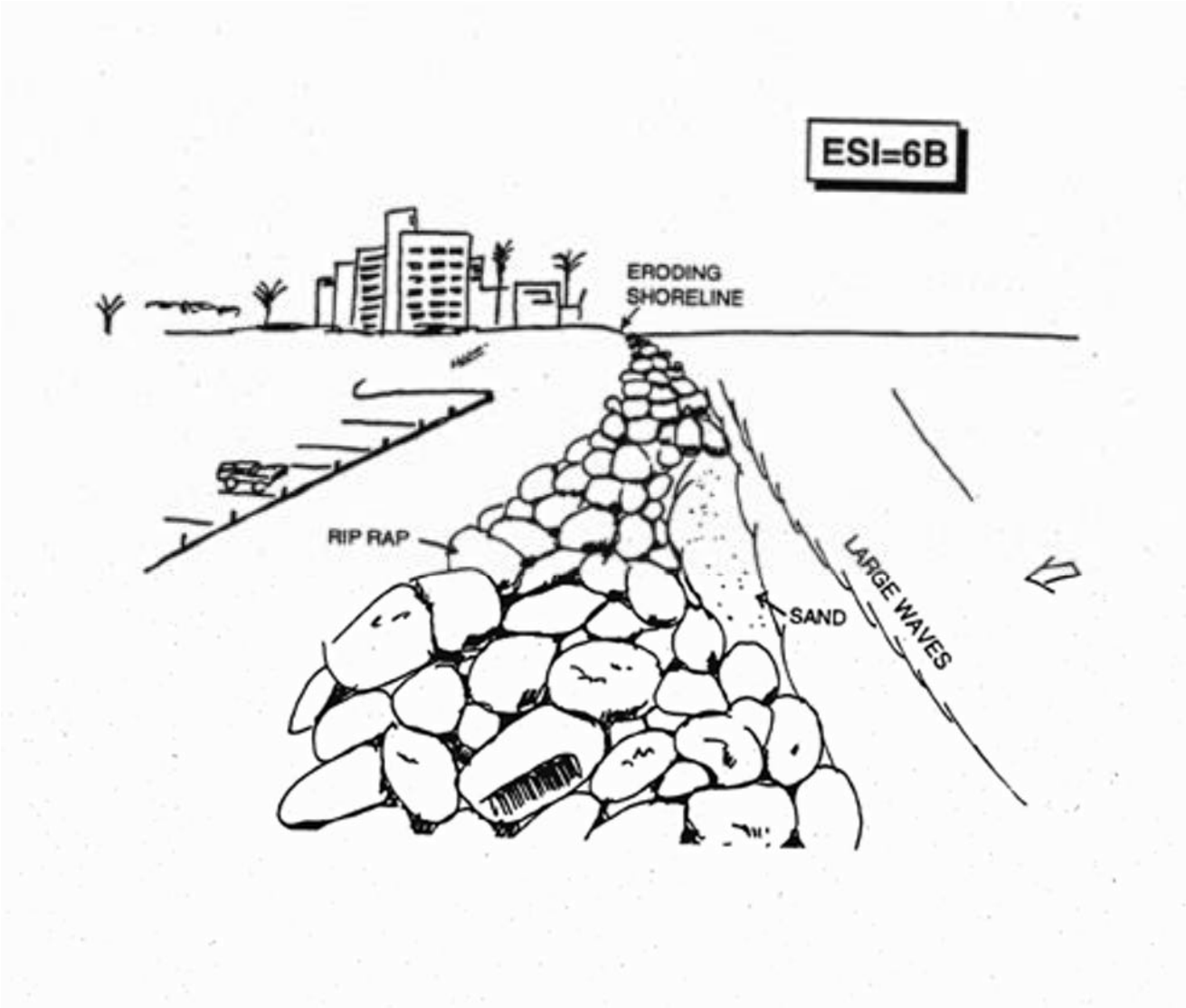
- Riprap consists of large rocks as well as concrete armor units (tetrapods, dolos, etc.).
- Riprap is present in harbor entrances and along developed areas for shore protection.
- Biomass is generally low in high energy areas, but attached organism density and species diversity are higher at more protected sites.

Predicted Oil Impact

- Heavy oil would coat the surface as well as penetrate and completely fill the cavities in riprap structures.
- In exposed areas, waves would remove surface contamination.
- In lower-energy areas, oil would tend to seep out of the oil-filled cavities slowly, generating sheens that can recontaminate adjacent shorelines.
- If oil is left to harden, an asphalt pavement may result.

Recommended Response Activity

- High-pressure spraying of oiled riprap may help in cleaning exposed surfaces but would have little effect on oil that penetrated deeply into the riprap.
- For small areas of contamination, riprap units can be manually wiped or scraped to remove oil.
- It may be necessary to remove heavily oiled riprap and replace it.
- Sometimes, the only option is to use snare booms to pick up oil as it is naturally removed.


ESI=6B
ERODING
SHORELINE
RIP RAP
SAND
LARGE WAVES

ESI=7 Exposed Tidal Flats

Description

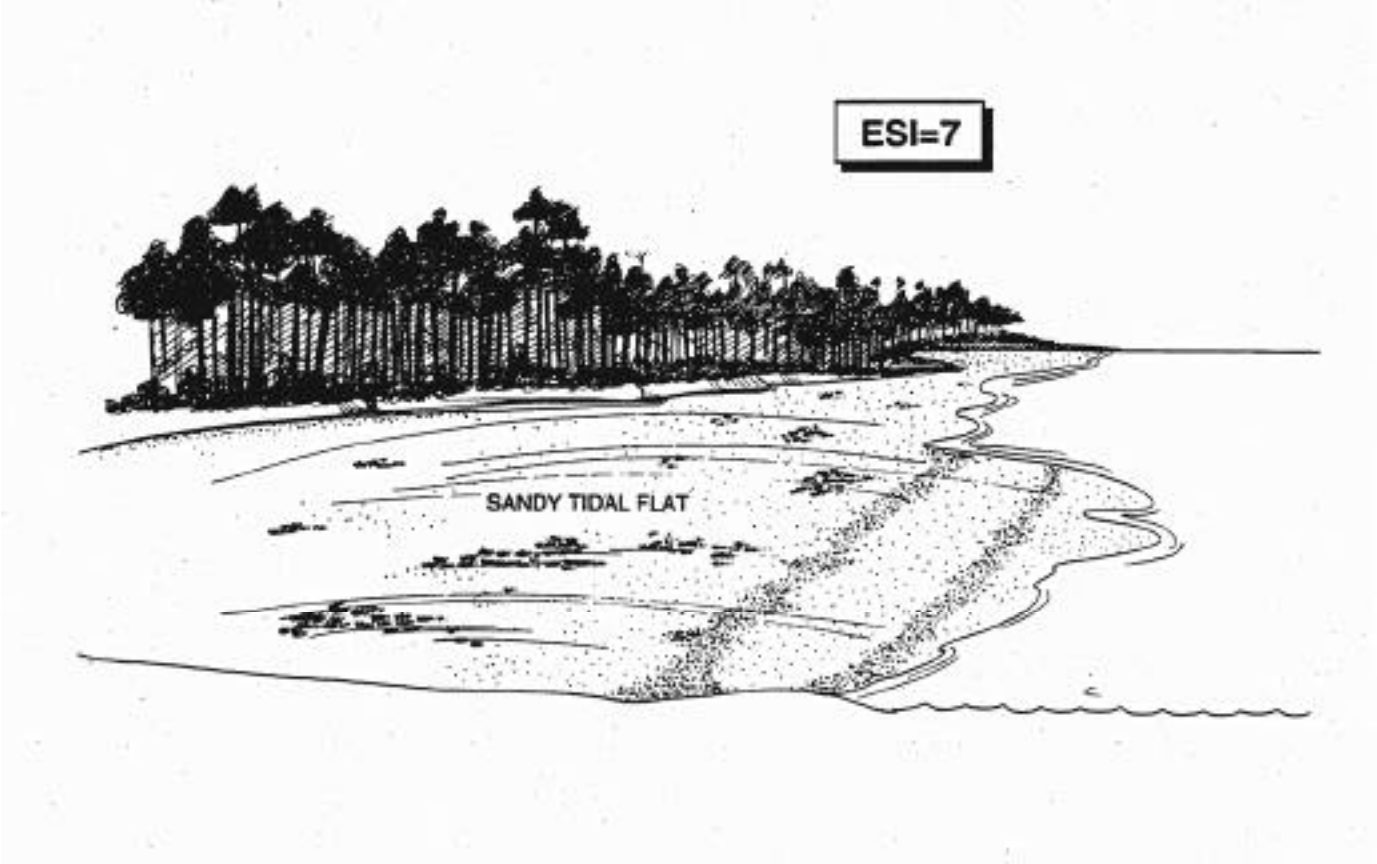
- They are an uncommon shoreline type in tropical U.S. waters because of the small tidal range in the Caribbean Sea and open Pacific Ocean.
- They are present near river mouths in areas sheltered by barrier reefs or wide fringing reefs, in the lee of offshore islands, or near tidal inlets.
- The dominant grain size is sand, perhaps with minor amounts of mud and gravel.
- They are exposed to moderate wave and tidal current energy.
- They are always associated with another shoreline type on the landward side of the flat.
- Biological utilization can be very high, with large numbers of organisms and heavy use by birds for roosting and foraging.
- Intertidal benthic algae may dominate this habitat.

Predicted Oil Impact

- Heaviest concentrations would be along the high-tide line.
- Most oil would be transported across the flat with the rising tide; seldom would oil adhere to the tidal flat or be buried.
- Heavy accumulations would cover the flat during low tide.
- Oil does not penetrate the water-saturated sediments, except into burrows in the upper intertidal zone, but it may coat the attached algae, particularly if it is dead or dries out during exposure at low tide.
- Biological impacts may be severe, primarily to organisms, thereby reducing food sources for birds and other predators.

Recommended Response Activity

- Cleanup is difficult; therefore these areas require priority protection.
- Cleanup is possible only during low tides.
- The use of heavy machinery should be avoided at all times.
- Cleanup efforts should concentrate on removing oil and oily debris along the high-tide line.
- Operations should be conducted from boats to minimize sediment disturbance.


ESI=7
SANDY TIDAL FLAT

ESI=8 Sheltered Rocky Shores and Coastal Structures

Description

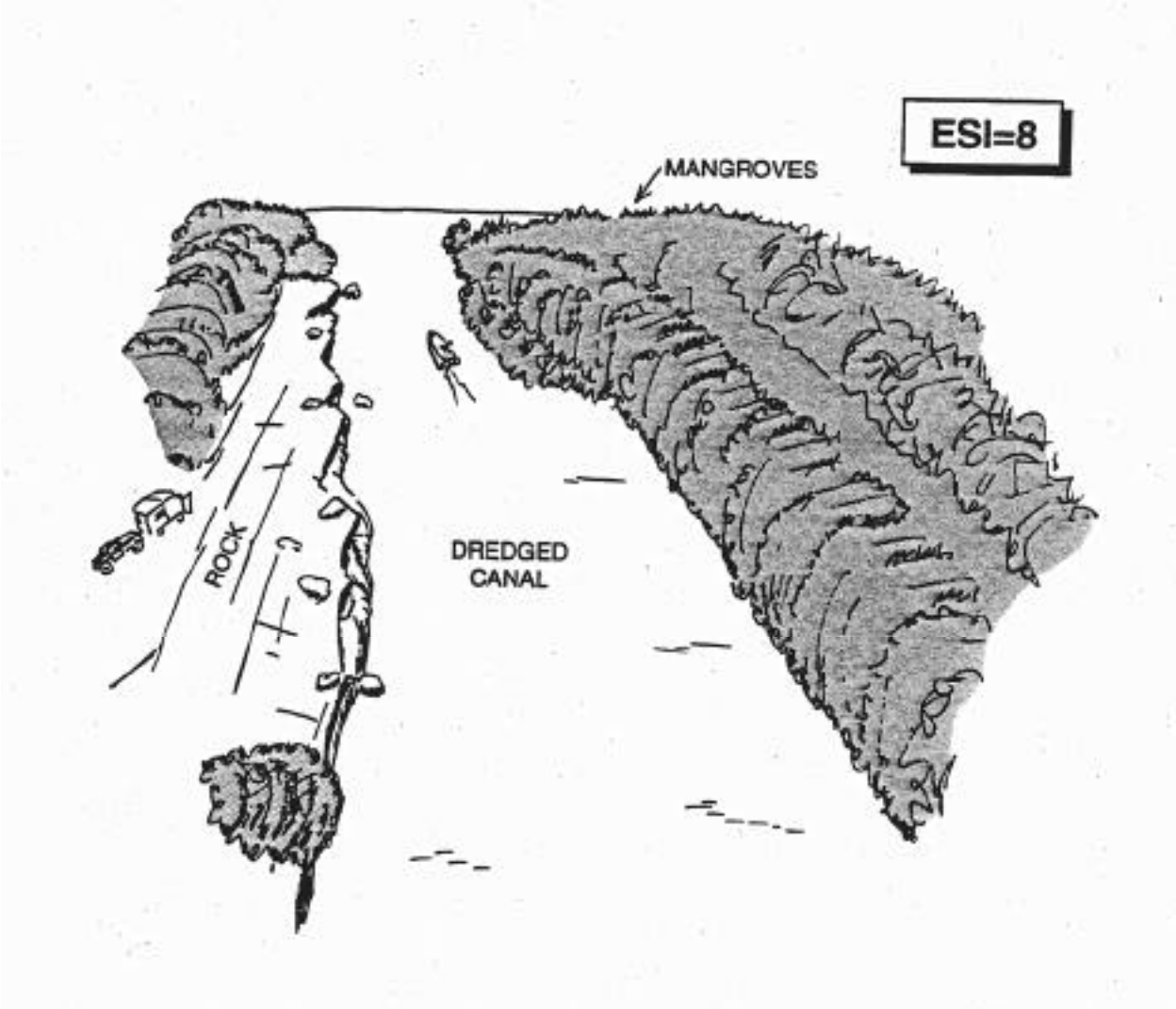
- Sheltered rocky shores occur in small coves and bays, and in developed areas where canals have been dug into bedrock.
- They occur as vertical rock walls and boulder-strewn rocky ledges.
- Seawalls, piers, bulkheads, and other structures can dominate developed shorelines along harbors and bays.

Predicted Oil Impact

- Oil would coat the intertidal surfaces of rocky shores and seawalls.
- Oil would penetrate into the joints and voids of the rocks.
- On vertical surfaces, the oil would form a distinct oil band along the high-tide line; the lower half of the rock face usually stays wet enough to prevent oil from adhering and remaining.
- Heavy oil accumulations can coat the entire intertidal zone.
- Oil may persist for weeks to months; fresh oil and light refined products have high acute toxicities, which can affect attached organisms after even short exposures.
- Biota living on the surface (e.g., urchins, crabs, snails) would be impacted.

Recommended Response Activity

- High- and low-pressure water spraying of the rocky surfaces and seawalls may be required:
  - To remove oil
  - To prepare area for recolonization of epifauna
  - For aesthetic reasons, in populated areas
  - To prevent the chronic leaching of oil from the surface
- High-pressure spraying of coastal structures should be conducted only when the tide is high, to prevent the released oil from adhering to the sediments at the base of the structures. Sorbents can also be used to recover the oil.


ESI=8
MANGROVES
ROCK
DREDGED
CANAL

ESI=9 Sheltered Tidal Flats

Description

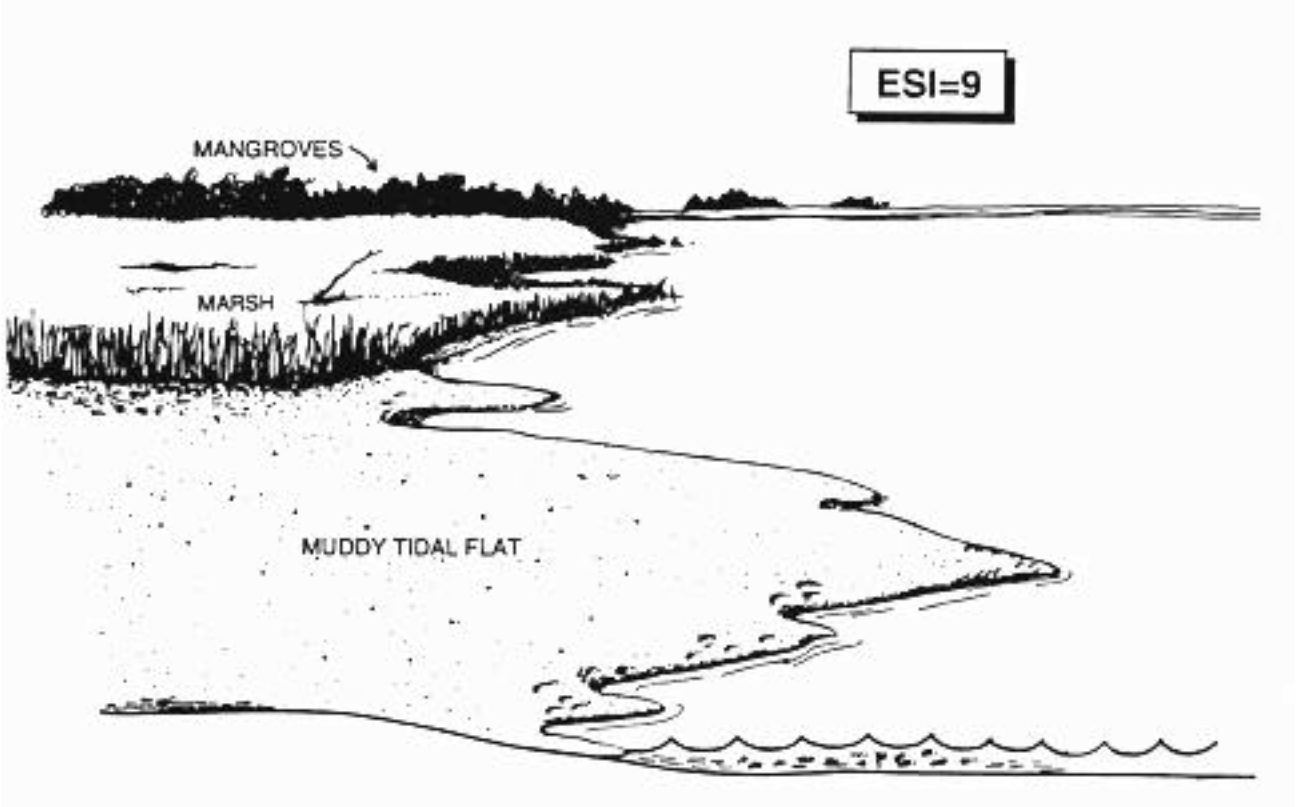
- Sheltered tidal flats are not common, because of the small tidal range.
- They are often associated with mangroves.
- They are composed predominantly of mud, but may contain sand and/or gravel, and are sheltered from wave and tidal energy.

Predicted Oil Impact

- Oil would most likely to be transported across the tidal flat and deposited along the high-tide line in the accumulated wrack deposits.
- Very heavy accumulations can cover much of the flat surface, but penetration would not occur into the water-saturated sediments of the flat, except possibly into burrows at the high-tide line.
- Long-term contamination of muddy tidal-flat sediments is possible in areas of high suspended sediments through the sorption of the oil on these particulates.
- Oil stranded at the high-tide line or mixed into the sediments may persist for many years; natural removal is very slow.
- Organisms living in and on the sediments would be impacted.

Recommended Response Activity

- These environments are high-priority areas necessitating the use of spill protection devices such as booms to prevent or minimize oil impact.
- Foot traffic on oiled tidal flats should be prohibited.
- If cleanup is necessary, it should be restricted to the upper reaches of the high-tide swash line or be conducted from boats.
- Passive cleanup efforts such as deployment of sorbent boom can be used to recover oil as it is removed naturally, but they must be changed frequently to be effective.
- Any cleanup should be supervised closely to minimize the mixing of oil into the sediment during the cleanup effort.


ESI=9
MANGROVES
MARSH
MUDDY TIDAL FLAT

ESI=10A Mangroves

Description

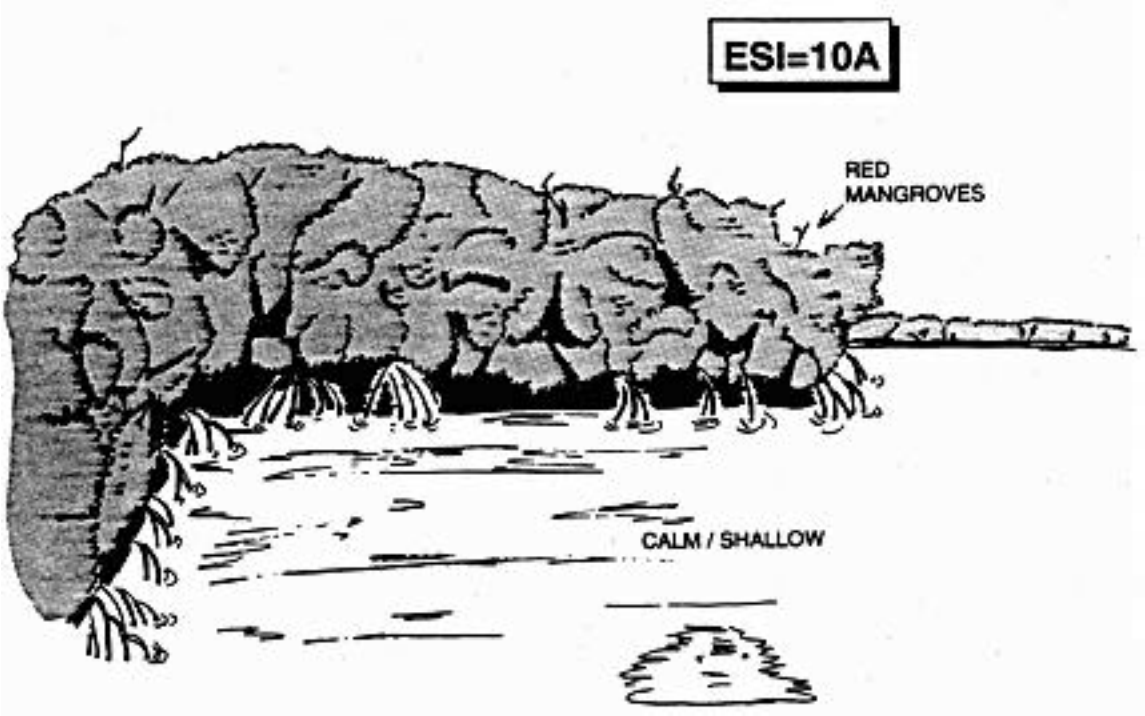
- Mangroves are the most sensitive shoreline habitat to oil-spill effects.
- Mangrove forests can range in width from one to hundreds of meters.
- Red (*Rhizophora*) and black (*Avicennia*) mangroves are the most common mangrove species.
- The sediment ranges from thin to thick layers of sand and mud, to muddy peat on bedrock, to a rubble veneer on bedrock.
- They can vary widely in the degree of exposure to wave and tidal energy, with exposed forests along the outer shoreline and sheltered forests in bays and estuaries well-protected from physical processes.
- There can be many storm swash lines of heavy wrack deposits deep into the forest.
- The mangrove roots support a rich diversity of attached animals and plants.

Predicted Oil Impact

- As oil enters mangrove forests, their roots and associated epiphytic communities would be covered with a band of oil.
- Degree and type of acute mortality is oil-type dependent:
  - Light oils (gasoline, jet fuel, No. 2 fuel oil) would have acute, toxic effects to both trees and intertidal biota
  - Crude oils / heavy refined products are toxic due to coating and sediment contamination
- Oiling of sediments would occur if large quantities of oil were washed ashore; of particular concern are organic-rich sediments that are exposed at low tide.
- No. 2 fuel oil would have the greatest effects due to penetration; it can persist and remain toxic for many years if it penetrates burrows and prop root cavities.
- Persistence would be long-term with heavy oil accumulations.
- A beach berm fronting the mangroves would normally limit oil contamination to the seaward side of the berm, preventing oiling of forest interiors.

Recommended Response Activity

- These highly sensitive areas are very difficult to clean up and thus require the highest protection priority.



- Under most conditions, the best practice is to allow natural recovery, especially where natural cleaning can occur.
- Placement of sorbent boom along the mangrove forest fringe may reduce the quantity of stranded oil significantly.
- Booms should be deployed in an attempt to protect the most sheltered areas where greatest persistence is likely.
- However, deployment of boom is seldom effective with light refined oils because of the low viscosity of these products.
- Heavy accumulations should be skimmed or flushed with low-pressure water flooding, as long as there is NO disturbance or mixing of oil into the substrate. If substrate mixing is likely or unavoidable, it is better to leave the oil to weather naturally.
- Oily debris and wrack can be a source of chronic sheening and should be removed, taking care not to disturb the substrate.
- Vegetation should never be cut or otherwise removed.
- Sorbents can be used to wipe heavy oil coating from prop roots in areas of firm substrate. Close supervision of cleanup is required.
- Nutrient addition may be an option for treatment of residual oil contamination in mangrove sediments. Effectiveness would have to be evaluated case-by-case.

ESI=10B Other Estuarine Wetlands

Description

- Many of the river systems on tropical islands contain estuarine wetlands which, in some areas, extend over 1 km inland.
- Principal plants on Pacific Ocean Islands include the Nipa palm (*Nypa fruticans*), pago (*Hibiscus tiliaceus*), tangan-tangan (*Leucaena* sp.), bamboo, and miscellaneous grasses, among others.
- These wetlands have high density and diversity of plants, and they are important habitats for many animals.

Predicted Oil Impact

- Estuarine conditions allow the possibility for oil to be transported into these wetlands during flood tides.
- Specific effects of oil on many of these species is unknown, but wetlands are usually heavily impacted during oil spills.
- Oil adheres readily to the vegetation.
- The band of coating would vary widely, depending upon the tidal stage at the time that the oil slicks are in the vegetation. There can be multiple bands.
- Large slicks would persist through multiple tidal cycles and coat the entire plant from the high-tide line to the base.
- Fresh crudes and heavy oils would tend to “slide” down the stem over time in warmer weather and pool on the sediments at the base of the plant.
- Weathered oils do not “slide” as much; the oil stays on the vegetation.
- If the vegetation is thick, heavy oil contamination can be restricted to the outer fringing vegetation, with penetration and lighter oiling further inland.
- Lighter oils (light refined, fresh crudes) can penetrate deeply into the wetland, to the high-tide line.
- Medium to heavy oils do not readily adhere to or penetrate the wet, muddy sediments, but they can pool on the surface and in burrows.
- Light oils can penetrate the top few cm of sediment and deeply into burrows and cracks (up to 100 cm).

Recommended Response Activity

- These highly sensitive areas are very difficult to clean up, therefore they require the highest of priority protection.
- Under most conditions, the best practice is to allow natural recovery, especially where natural cleaning is effective, such as along river channels exposed to wave and tidal energy.
- Placement of sorbent boom along the vegetative fringe may reduce the quantity of oil impacting the area.
- Deployment of boom is seldom effective with light refined oils because of the low viscosity of these products.
- For other products, booms should be deployed to attempt to protect the most sheltered areas where greatest persistence is likely.
- Heavy accumulations should be skimmed or flushed with low-pressure water flooding, as long as there is NO disturbance or mixing of oil into the substrate. If substrate mixing is likely or unavoidable, it is better to leave the oil to weather naturally.
- Oily debris should be removed, taking care not to disturb the substrate.
- Live vegetation should not be cut or otherwise removed.
- These activities should be closely supervised.

Special Considerations

Coral Reefs

Description

This section deals with coral reefs, that is, structures which are created and maintained by the establishment and growth of populations of hermatypic coral and coralline algae. Coral reefs are mostly subtidal in nature, although the most shallow portions of some reefs can be exposed during very low tides. The four major categories of reefs are:

- *Fringing reefs* - long, narrow bands of coral reefs parallel to and near the shoreline. When near coastal development, they are susceptible to stress from sedimentation and chronic pollution.
- *Barrier reefs* - similar to fringing reefs except that they are further offshore and much broader.
- *Atoll reefs* - reefs formed by the buildup of coral on the rim of a subsiding volcano. They are circular or portions of a circle, forming a sheltered lagoon.
- *Patch reefs* - small, irregularly shaped coral reefs that occur in isolated patches rather than long bands.

Recent studies have found that many coral species throughout the world spawn simultaneously over a very short time period (days), a behavior which makes the entire year's recruitment very vulnerable.

Predicted Oil Impact

- Oil would usually pass over subtidal reefs with no direct contamination.
- Exceptions where floating oil would potentially coat living reef communities are:
    - Landward border of fringing reef platforms which are exposed at low tide
    - Certain reef-flats which are floored with bedrock and may have high coral heads growing on them, and
    - The outer, seaward part of reef-flat platforms that are usually slightly elevated and are consequently exposed at low tide and heavily washed by waves
- Except in the event of extremely heavy oil concentrations, oil would be readily removed from these reef areas with the rising tide. This is especially true of the outer reef platform.

- There is little documentation of long-term impacts to coral reefs from oil spills, except in the situations where the pollution is chronic, or in the rare instance where oiled sediments might be transported to the bottom. The best case history is a five-year study of the corals impacted by the Texaco spill in Panama.
- Studies have shown sublethal impacts to coral from oil spills, with short-term recovery.
- Greatest impacts to the reef would result from spills of light refined products directly into the shallow waters overlying reefs and where high concentrations of water-soluble fractions persist. Also, large spills during the period of simultaneous spawning could affect the larvae of all coral species, regardless of water depth.
- Of greater concern at most spills are the organisms that concentrate around the coral reef habitat.

Recommended Response Activity

- Sorbents and booms should be used to prevent oil from being transported over the reefs.
- No cleanup is recommended. Cleanup of the reef itself by natural processes is expected to be rapid.
- Oil should be removed from adjacent intertidal areas to prevent chronic exposure of the corals to oil leaching from these sites.
- Any use of sorbents should be limited to those that can be contained and recovered.

Seagrasses

Description

Seagrasses in tropical environments in the Caribbean and U.S. Pacific territories are dominated by turtlegrass (*Thalassia sp.*), manatee grass (*Syringodium sp.*), and shoalgrass (*Halodule sp.* and *Enhalus sp.*). Their distribution is limited by water temperature, light penetration (thus turbidity and water depth), and salinity. Seagrasses play a very important role in shallow coastal marine environments, including:

- Sediment stabilization.
- Detritus production which provides a major basis of food chains, although the bulk of the biomass is in the sediments (in the rhizomes).

- Substrate for a highly productive epiphytic community, with a total biomass which often approaches or exceeds that of the plants themselves.
- A directly utilized food source for a few organisms, namely turtles, who graze on seagrasses.
- Habitat which is utilized by fish and shellfish as nursery areas.
- Key role in nutrient cycling, including nitrogen, phosphorous, and sulfur.

Predicted Oil Impact

- Greatest impacts occur on seagrasses that are intertidal, where the oil comes in direct contact with exposed blades.
- Oil readily adheres to exposed blades, particularly when the oil is heavy or weathered.
- Unless the sediments are also oiled, any oiled blades are quickly defoliated and the plants have the capacity to grow new leaves (the leaves grow from a relatively protected meristem). Recovery can occur with 6-12 months.
- Plant mortality has been observed at spills when the sediments were contaminated by oil, although such incidents have been rare.
- The most sensitive component of the seagrass ecosystem is the epiphytic community and juvenile organisms using the grass beds as a nursery. These species and life stages can be highly sensitive to both the water-soluble and insoluble fractions of oil.
- The plants can uptake hydrocarbons from the water column and sediments, potentially lowering their tolerances to other stresses.

Recommended Response Activity

- Where possible, oil should be prevented from entering shallow, sheltered areas where seagrass beds occur. Highest priority should be those beds which are known to provide nursery areas for commercially important species.
- Little can be done to protect seagrass beds along exposed sections of shoreline.
- Extreme care should be taken not to disturb the sediments during cleanup operations in the vicinity of seagrasses, which could result in total loss of the seagrass bed.
- Cleanup efforts onshore should not result in the deposition of oiled sediments in the beds, e.g., from water flushing of intertidal substrates.

- Oiled wrack on adjacent beaches should be removed quickly, to prevent re-entry of oiled detritus into the nearshore environment.
- Removal of oiled blades should only be considered when it can be demonstrated that special species (such as endangered turtles) are at significant risk of injury from contact or grazing on the blades.
- Otherwise, the best strategy for oiled blades is to allow natural recovery; the oiled blades are sloughed off within days to weeks.

Turtle Nesting Beaches

Description

This section deals with beaches which are used by turtles for laying and incubation of eggs. The most sensitive life stages are the eggs when they are buried in the sand, the hatchlings as they dig their way out of the nest and enter the water, and young juveniles which are pelagic surface dwellers. Important aspects of the life histories of the five species of sea turtles which spend part of their lives in coastal waters (Kemp's ridley, loggerhead, green turtle, hawksbill, and leatherback) are:

- Sea turtles may nest every 1-4 years after reaching maturity (which is estimated to take 10-50 years).
- The female may lay anywhere from 1 to 10 clutches of about 100 eggs per season, depending on the species.
- The nests are normally located above the high-tide level.
- Incubation takes about two months.
- The greatest source of natural mortality of sea turtles is probably predation of hatchlings in the ocean.
- There is strong nesting beach fidelity.

Predicted Oil Impact

- The greatest threat of oil spills on land is the toxic effects of direct contamination of eggs in the nest. However, it should be noted that, because the eggs are laid above the high-tide line, direct oiling is unlikely when it occurs during nesting.
- The number of unhatched eggs is much higher when fresh crude oil is on the sand surface during the last half to quarter of the incubation period. This effect is thought

to be due to displacement of oxygen by the lighter oil fractions when the rate of oxygen consumption is at its peak.

- Many weathered crude oils are less toxic to turtle eggs than fresh crude oils.
- Hatchling morphology is affected by the amount of oil and time of oiling. Weights are lower and sizes are smaller when the eggs are exposed to a light dosage of oil mixed in the sand.
- Young turtles exposed to oil in water in tests have demonstrated disturbed diving and respiratory patterns, decreased blood glucose levels, reddening and sloughing off of the skin, and dysfunctioning of the salt glands.
- Turtles feed on floating objects, therefore they are susceptible to ingestion of tarballs and coating of oil on their flippers and in their mouths.

Recommended Response Activity

- Removal of eggs from nests along beaches under immediate threat of oiling is seldom an option because the eggs should not be moved after 24 hours post-laying. The yolks and embryos settle to one side within 48 hours, thus any movement after that period usually results in decreased viability.
- Only experienced or trained personnel should attempt to move threatened eggs.
- Nesting beaches should receive highest priority for cleanup if they are oiled prior to the nesting period.
- Rapid removal of oil from a beach with active nests may be attempted, particularly if the oil has not reached the nest sites.
- If hatchlings emerge while oil is coming onshore and slicks are still in nearshore waters, hatchlings should be captured and released in clean waters.
- Hatchlings usually emerge during night hours, so nests should be monitored to intercept hatchlings before they swim into contaminated waters.
- Cleanup activities on nesting beaches should be monitored by experienced personnel so that the nests are not physically disturbed.

Other special considerations may need to be developed for:

Birds

- Rookeries and nesting sites
- High concentration migration stopovers

Marine Mammals

- Population concentration areas

Terrestrial Mammals and Plants

- Concentration areas
- Threatened and endangered plants adjacent to the shoreline

Fish and Shellfish

- Estuarine areas which are important fish nursery areas
- Shellfish seed beds and nursery areas, high concentration areas

Recreation

- High-use recreational beaches
- Marinas and boat ramps
- High use boating, fishing, and diving areas

Management Areas

- State marine parks/federal marine sanctuaries
- Wildlife management areas and refuges
- Nature preserves and reserves

Resource Extraction

- Commercial fishing areas
- Aquaculture sites
- Subsistence harvest areas
- Water intakes

Cultural Resources

- Archaeological and other historically significant sites

3 Shoreline Mapping and Prioritization

Guidelines for Shoreline Surveys

At most spills, a repetitive, detailed, and systematic survey of the extent and degree of shoreline contamination is needed to:

1. Assess the need for shoreline cleanup
2. Select the most appropriate cleanup method
3. Determine priorities for shoreline cleanup
4. Document the spatial oil distribution over time
5. Maintain internally consistent historical record of stranded oil distribution for use by other scientific surveys of intertidal and subtidal impacts.

Though general approvals for use of shoreline cleanup methods are to be developed during planning stages, site-specific cleanup recommendations must be based on field data on the shoreline types and type and degree of shoreline contamination. Thus, shoreline surveys become a very important component of the decision-making process, and they must be conducted in a systematic manner. Also, repeated surveys are needed to monitor the effectiveness and effects of on-going treatment methods (any migration of beached oil, as well as natural recovery), so that the need for additional treatment or constraints can be evaluated.

Several methods of data collection can be used to obtain information on shoreline character and degree of oil contamination. For example, aerial surveys provide reconnaissance-level information that is necessary for broad scale evaluations, definition of the impacted area, and general characterization of the oiling conditions. During aerial surveys, observers should note presence of resources at risk that need immediate protection, recommendations for boom deployment sites, access points, or restrictions, etc.

Ground surveys provide detailed information necessary for site-specific decisions on shoreline treatment techniques. The methods and forms for ground surveys described here have been modified from those developed by Exxon and their contractors during the 1989 *Exxon Valdez* oil spill in Prince William Sound (Owens and Teal, 1990). These methods

have been revised for application to specific regions, such as the Oil Spill SCAT Manual for the coastline of British Columbia (Environment Canada, 1992). Guidance on methods and forms for use in ground surveys are described in the following section.

Ground Surveys

The primary purpose of ground surveys is to collect information on the extent of oiling on various shoreline types and to feed this information into the decision-making process for shoreline cleanup. Thus, it is imperative that survey teams use consistent methods and terminology throughout the spill event. A series of forms have been developed as the basis for data collection and reporting. Field teams should conduct a training program so all members understand the objectives, methods, data forms, terms, etc., and to insure standardized application. The teams need to visit at least one site as a group so that their observations can be calibrated.

At a large spill, the scientific members of the Shoreline Assessment Team usually consist of the following:

Oil Spill Scientist/Coastal Geologist (OG)

Should have at least B.Sc. degree in geology or physical geography and oil-spill experience, plus familiarity with shorelines of impacted area. Responsible for logistical/direction and detailed documentation (i.e., completion of Shoreline Survey Evaluation Form).

Ecologist (ECO)

Should have degree in biology and oil-spill experience, plus familiarity with the local affected habitats and organisms. Responsible for characterization of the intertidal communities and assessing affects of oil or cleanup efforts.

Archaeologist (ARCH)

Usually a M.S.- or Ph.D.-level archaeologist. Main responsibilities are identifying and updating archaeological and historical sites, and determining potential impacts of oiling or cleanup measures.

In addition to the core scientific group, the team also usually has representatives of: (a) operations group of the party responsible for cleanup; (b) the State government; (c) the Federal Government; and (d) the land owner or manager. At smaller spills or under emergency conditions, team members may have to assume more than one role.

Selecting and Naming Segments

The general approach is to divide the impacted area into segments, which are sections of the oiled shoreline for which detailed observations are recorded. The size of segments depends on the variabilities in degree of oiling and shoreline type. Boundaries of the segments should be defined where the shoreline geomorphology or degree of oiling changes significantly. However, it should be noted that new forms are completed for each segment, so the interval should not be so small that the number of forms required becomes unmanageable for the size of the spill. Segment lengths up to several kilometers would be acceptable for large spills, where smaller spills may have lengths in the hundreds of meters.

Numbering of the segments in a logical order helps location recognition. Usually an alpha-numeric code is employed, with two-letter abbreviations for the local area (e.g., HB for segments located along the Hanama Bay and CI for those on Coconut Island), and numbers for each segment in the order it was surveyed. Thus, if Coconut Island was divided into four segments, they would be designated as CI-1 through CI-4. The boundaries of the segments would be delineated on detailed maps.

The Shoreline Survey Evaluation Forms

For each segment, the Shoreline Survey Evaluation Form should be completed. Two versions of a Shoreline Survey Evaluation Form have been included in this manual. This section briefly outlines the methods to be used to complete the long form.

The Shoreline Terminology / Codes sheet lists the common terms and abbreviations to be used to describe the oil, sediments, and other features on the forms and sketch maps. The blocks on the Shoreline Survey Evaluation Form, where the codes are used, are indicated on the sheet. One member of the team, usually the OG, should be responsible for completing the forms, although all members collect the field data. The segment is walked and observations on the oiling conditions are recorded. It is very important to make accurate measurements or estimates of the dimensions of each type of oil. Areas containing surface oil are shown on a field sketch of the shoreline segment. The oiled sites, which are designated by letters, are described systematically by filling in Block 6 of the Shoreline Survey Evaluation Form. A blank sketch form is attached, and an example is included for illustration purposes.

Subsurface oil is investigated by digging trenches and recording measurements of the degree and depths of subsurface oil. Each trench is numbered, and the location of each trench should be shown on the sketch. A symbol is used to differentiate between oiled and clean

trenches (filled-in versus open triangle). The sketches are a very important component of the field survey data; they are better than photographs at depicting overall conditions. Sketches help reviewers put the tabular data on oiled area and type in perspective, thereby facilitating decision making. They provide documentation in a manner not achieved by photographs, videotapes, or statistics, and they allow ready comparisons over time.

The objective of the surveys should always be kept in mind: to collect the information needed by operations personnel and decision makers to formulate and approve shoreline treatment plans. An operations manager should be able to use the data to develop a detailed cleanup plan, including equipment and manpower needs, from these surveys. Government agencies should be able to use the data, along with natural resource information, to develop cleanup priorities, identify site-specific or temporal constraints, and approve the proposed cleanup plan.

The Comment section and sketch map will be important references for documentation of sensitive resources and impacts. The Comments section should highlight the information the field team considers to be very important to the shoreline treatment decision making. The Comments section is also where the field team makes treatment recommendations that would best remove the oil without causing further environmental damage, or identify specific constraints that should be incorporated into the cleanup plan.

Abbreviated Shoreline Surveys

Comprehensive surveys, as outlined above, are not always appropriate for smaller spills, or those that are relatively simple in oiling conditions. Yet, there is still the need for systematic observations and documentation of shoreline oiling conditions and cleanup progress. An abbreviated shoreline survey at smaller or less complicated spills would consist of:

- Trained team(s) with members from State and Federal response agencies, the cleanup contractor, and responsible party to document shoreline oiling conditions.
- Consistent terminology for description of oiling conditions and of shoreline features.
- Segmentation of the oiled areas into sections by shoreline type, degree of oiling, etc., and for which specific cleanup recommendations can be made.
- Field sketches to identify the area surveyed, record oil observations, identify sensitive areas to avoid, and utilize as the basis for a work plan by cleanup crews.
- Simplified forms for recording observations, making recommendations for cleanup, listing segment-specific restrictions, and generating summary statistics on shoreline

oiling conditions. The forms would also document team composition, samples, photographs, etc., for each segment.

The Shoreline Survey Evaluation Short Form was developed to meet the documentation requirements at smaller spills. The form contains space for recording measurements of the length and degree of shoreline contamination, but allows for textual descriptions of the oiling conditions. It is important that the standard terms be used in these descriptions and that specific features be shown on the field sketch. The Short Form also includes space for recording segment-specific considerations for cleanup operations. This section would include information on the location of areas that should be avoided or that require special care or restricted activities by cleanup crews. For example, the location of sensitive wildlife such as eagle nests would be noted in this section. Sites to be avoided, such as archeological sites or private property, would be delineated. Photographs and samples taken at the site would be recorded in the section for Other Comments.

Surface Oil Cover Summary

As the shoreline surveys are being completed, a rating system must be used to describe and summarize the surface oil conditions on the shoreline. These conditions are:

- Heavy
- Moderate
- Light
- Very Light

These ratings are assigned based upon the Oil Category Width and the Surface Oil Distribution, as defined on the sheet on Shoreline Oil Terminology / Codes. Following is an Initial Surface Oil Cover Matrix for use during spills.

		Width of Oiled Areas			
		Wide >6 m	Medium >3 - 6 m	Narrow >0.5 - 3 m	Very Narrow <0.5 m
Oil Distribution	Continuous 91 - 100%	Heavy	Heavy	Moderate	Light
	Broken 51 - 90%	Heavy	Heavy	Moderate	Light
	Patchy 11 - 50%	Moderate	Moderate	Light	Very Light
	Sporadic 1 - 10%	Light	Light	Very Light	Very Light
	Trace <1%	Very Light	Very Light	Very Light	Very Light

Shoreline Oil Terminology/Codes 11/5/92

Shoreline Slope (Enter in Block 3)

Low	Less than 30 degrees
Medium	Between 31 and 60 degrees
High	Between 61 and 90 degrees
Vertical	Vertical or near vertical

Oil Category Width (Enter in Block 4)
(To be determined for each segment, depending on width of the intertidal zone)

W	Wide	> 6 m wide
M	Medium	> 3 m to ≤ 6 m
N	Narrow	> 0.5 m to ≤ 3 m
V	Very Narrow	≤ 0.5 m

Oil Distribution (Enter in Block 5)

C	Continuous	91 - 100%
B	Broken	51 - 90%
P	Patchy	11 - 50%
S	Sporadic	1 - 10%
T	Trace	<1%

Surface Oiling Descriptors - Thickness (Enter in Block 5)

PO	Pooled Oil (fresh oil or mousse > 1 cm thick)
CV	Cover (oil or mousse from >0.1 cm to <1 cm on any surface)
CT	Coat (visible oil <0.1 cm, which can be scrapped off with fingernail)
ST	Stain (visible oil, which cannot be scrapped off with fingernail)
FL	Film (transparent or iridescent sheen or oily film)

Surface Oiling Descriptors - Type (Enter in Block 5)

FR	Fresh Oil (unweathered, liquid oil)
MS	Mousse (emulsified oil occurring over broad areas)
TB	Tarballs (discrete accumulations of oil <10 cm in diameter)
PT	Patties (discrete accumulations of oil >10 cm in diameter)
TC	Tar (highly weathered oil, of tarry, nearly solid consistency)
SR	Surface Oil Residue (non-cohesive, heavily oiled surface sediments, characterized as soft, incipient asphalt pavements)
AP	Asphalt Pavements (cohesive, heavily oiled surface sediments)
NO	No Oil
DB	Debris; logs, vegetation, rubbish, garbage, response items such as booms, etc.

Shoreline Oil Terminology/Codes 11/5/92

Subsurface Oiling Descriptors (Enter in Block 6)

SAP	Subsurface asphalt pavement (cohesive)
OP	Oil-Filled Pores (pore spaces are completely filled with oil, to the extent that the oil flows out of the sediments when disturbed). May also consist of weathered oil such as a buried lens of asphalt pavement
PP	Partially Filled Pores (pore spaces partially filled with oil, but the oil does not flow out of the sediments when disturbed)
OR	Oil Residue (sediments are visibly oiled with black/brown coat or cover on the clasts, but little or no accumulation of oil within the pore spaces)
OF	Oil Film (sediments are lightly oiled with an oil film, or stain on the clasts)
TR	Trace (discontinuous film or spots of oil, or an odor or tackiness)
NO	No Oil (no evidence of any type of oil)

Shoreline Zone (Enter in Blocks 5 and 6)

SU	Supratidal (above normal spring high tide levels)
UI	Upper Intertidal
MI	Middle Intertidal
LI	Lower Intertidal

Sediment Types (Enter in Blocks 5 and 6)

R	Bedrock outcrops
	Gravel
B	Boulder (>256 mm in diameter)
C	Cobble (64-256 mm)
P	Pebble (4-64 mm)
G	Granule (2-4 mm)
S	Sand (0.06-2 mm)
M	Mud (silt and clay, < 0.06 mm)
AR	Riprap (man-made permeable rubble)
AW	Seawalls (impermeable)
AP	Man-made pilings

Sheen Color (Enter in Block 6)

B	Brown
R	Rainbow
S	Silver
N	None

SHORELINE SURVEY EVALUATION FORM Page __ of __

1 GEN	Segment Name:_____	Survey	Survey (use military time)	
	Segment ID: _____	Date: _____	Time: _____ to _____	
	Surveyed From: Foot / Boat / Helicopter	Weather: Sun / Clouds / Fog / Rain / Snow		

2 TEAM	Team No.	Operations:	
	OG :	State:	for:
	ECO :	Federal:	for:
	ARCH :	Land Manager:	for:

3 SHORE	Overall Classification for UITZ–select one	Sediment Beach:	Sediment Flat:	
	Bedrock: Cliff ___ Platform ___	Boulder-Cobble __ Sand __	Boulder-Cobble __ Sand _	
	Manmade: Permeable ___ Impermeable ___	Pebble-Cobble __	Pebble-Cobble __	
	Marsh/Wetlands	Sand-Gravel __	Sand-Gravel __	
	Secondary Shore Type:	Backshore Type:		

4 LAND	Geomorphology	
	Slope: Low ___% Med. ___% High ___% Vert. ___%	Wave Exposure: Low / Medium / High
	Estimated Segment Length: m	Total Estimated Length Surveyed:
	Access Restrictions:	

5 OIL	Oil Category Width:		Total Pavement: _____ sq.m	by _____ cm
	Wide ____ m	Very Narrow _____ m	Patties/Tarballs _____ bags	Oiled Debris? Yes/No
	Medium ___ m	No Oil _____ m	Debris/Amount: Logs _____	Vegetation _____
	Narrow ___ m	Unsurveyed _____ m	Trash _____	Other _____

6 SURFACE OIL

SURFACE OIL	LOC	AREA LENGTH m	AREA WIDTH m	ZONE SU	ZONE UI	ZONE MI	ZONE LI	DIST	THICKNESS PO	THICKNESS CV	THICKNESS CT	THICKNESS ST	THICKNESS FL	TYPE FR	TYPE MS	TYPE TB	TYPE PT	TYPE TC	TYPE SR	TYPE AP	TYPE NO	SHORELINE SEDIMENT TYPE

Distribution (DIST): C = 100-91%; B = 90-51%; P = 50-11%; S = 10-1%; T = <1% Photo Roll # _____ Frames _____

7 SUBSURFACE

SUBSURFACE	NO.	TRENCHES SU	TRENCHES UI	TRENCHES MI	TRENCHES LI	TRENCH DEPTH cm	OILED ZONE cm-cm	SUBSURFACE OIL CHARACTER OP	OP PP	OR	OF	TR	NO	WATER TABLE cm	SHEEN COLOR	SURFACE-SUBSURFACE SEDIMENTS	CLEAN BELOW Y/N

Sheen Color: B = Brown R = Rainbow S = Silver N = None

8 COMMENTS

SHORELINE SURVEY EVALUATION SHORT FORM

1	G	Segment Name: _____	Survey	Survey (use military time)
	E	Segment ID: _____	Date: _____	Time: _____ to _____
	N	Surveyed From: Foot / Boat / Helicopter	Weather: Sun / Clouds / Fog / Rain / Snow	

2	T	Team No.			
	E	Name:	for:	Name:	for:
	A	Name:	for:	Name:	for:
	M	Name:	for:	Name:	for:

3	L	Shoreline Types:
	A	Sediment Types:
	N	Access Restrictions:
	D	

Length of Shoreline for Each Oil Category

		Oil Distribution	Wide (>6m)	Medium (3-6m)	Narrow (0.5-3m)	Very Narrow (<0.5m)	No Oil	Total Estimated Segment Length
4	O	Continuous (91-100%)	_____ m	_____ m	_____ m	_____ m		
	I	Broken (51-90%)	_____ m	_____ m	_____ m	_____ m	__ m	_____ m
	L	Patchy (11-50%)	_____ m	_____ m	_____ m	_____ m		
		Sporadic (1-10%)	_____ m	_____ m	_____ m	_____ m		

5 **Description of oiling conditions (use standard terms/refer to sketch)**

SURFACE OIL:

SUBSURFACE OIL:

6 **Segment-specific considerations for cleanup operations (sensitive wildlife areas to avoid, etc.)**

7 **Other Comments**

SKETCH MAP

11/05/92

Segment Name_____
Segment No._____
Date_____
Names_____

Checklist

__North Arrow
__Scale
__Oil Distribution
__High-Tide Line
__Low-Tide Line
__Substrate Types
__Trench Locations

Legend

1Δ
Trench Number.
No Subsurface Oil

2▲
Trench Number.
Subsurface Oil

SKETCH MAP

Segment Name OYSTERCATCHER BAY, CAL.
Segment No. CN-12
Date 20 October 1991
Names (OG) Y. B. Hadley

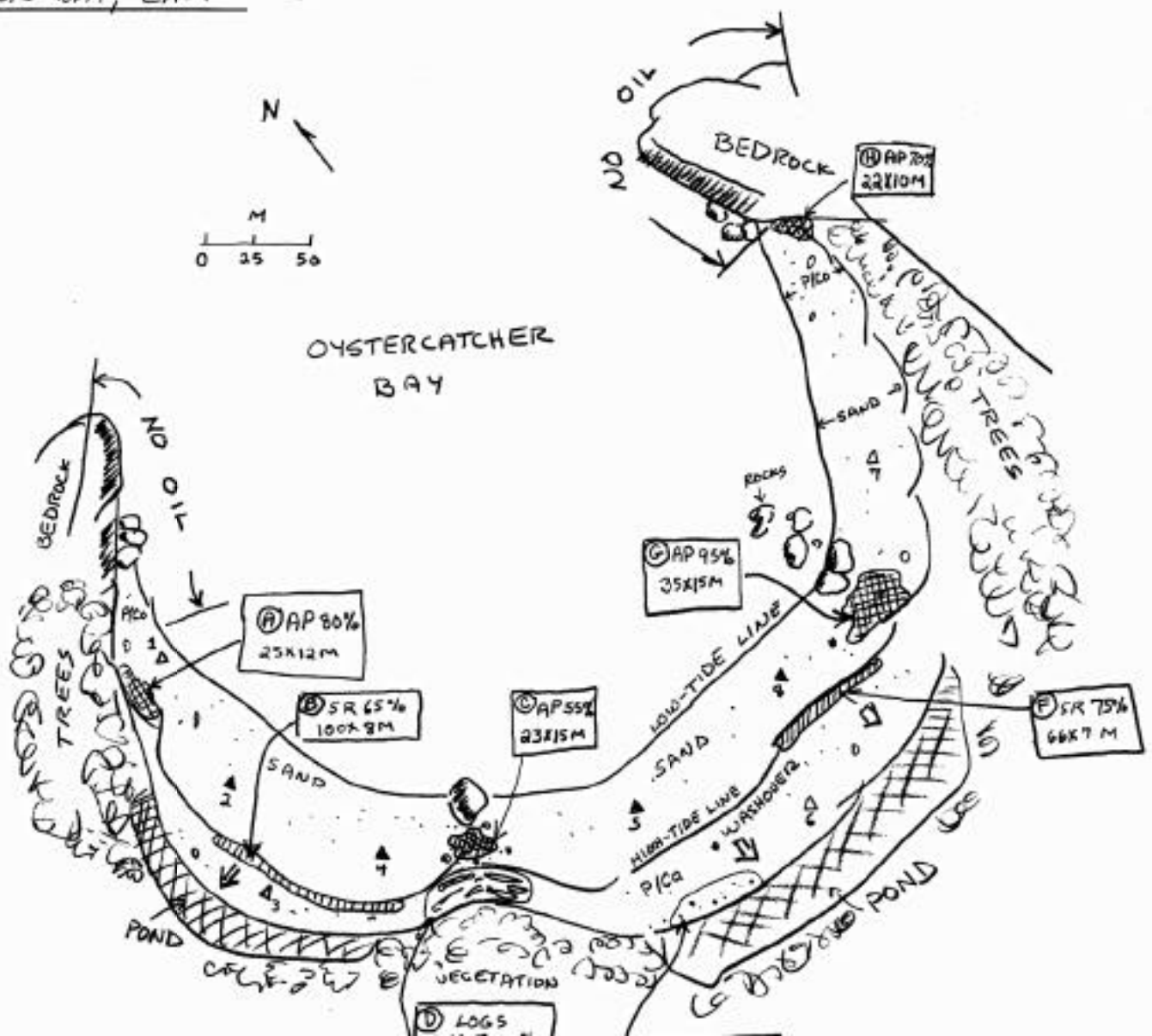
Checklist

- ✓ North Arrow
- ✓ Scale
- ✓ Oil Distribution
- ✓ High Tide Line
- ✓ Low Tide Line
- ✓ Substrate Types
- ✓ Trench Locations

Legend

1△
Trench Number.
No Subsurface Oil

2▲
Trench Number.
Subsurface Oil



4 Matrices of Recommended Countermeasure Methods by Oil and Shoreline Type

The matrices included in this chapter show which shoreline countermeasure techniques have been considered for the ten shoreline types described in Chapter 2. Four matrices have been constructed for the major categories of oil (very light, light, medium, and heavy).

Countermeasure methods are described in Chapters 5 and 6. Countermeasures in Chapter 5 are traditional techniques that the OSC can use without any additional concurrence. However, the cutting of vegetation countermeasure should be used only during specific seasonal windows under specific conditions and with landowner approval. Countermeasures in Chapter 6 are described under a separate section called "Treatment Methods Requiring Regional Response Team Approval" and may be useful in certain situations. The matrices are a particularly dynamic component of the manual and should continue to be revised as the existing techniques are used and evaluated, and as both old and new techniques are refined.

Each matrix has a written explanation of how it is to be used as a countermeasure advisability matrix. The matrix is only a general guide for removing oil from shoreline substrates. It must be used in conjunction with the entire "Shoreline Countermeasures Manual" plus field observations and scientific advice. The countermeasures listed are not necessarily the best under all circumstances, and any listed technique may need to be used in conjunction with other techniques (including ones not listed herein). The Federal On-Scene Coordinator (FOSC) or the State OSC operating with the FOSC's authorization has the responsibility for and authority to determine which countermeasure(s) are appropriate for the various situations encountered.

Selection of countermeasure techniques to be used in each spill is based upon the degree of oil contamination, shoreline types, and the presence of sensitive resources. Extremely sensitive areas are limited to manual cleanup methods. It is important to note that the primary goal of countermeasure implementation is to speed up or enhance environmental recovery of the shoreline habitats. Aesthetic considerations are secondary but also important. Nevertheless, shoreline countermeasures should cause no further injury or

destruction to the environment. The three categories of guidance used in the matrices are defined as follows:

R	Recommended	Method that best achieves the goal of minimizing destruction or injury to the environment
C	Conditional	Viable and possibly useful but may result in limited adverse effects to the environment
Shaded		Not recommended

Shoreline Countermeasure Matrix

Very Light Oils (Jet fuels, Gasoline)

* Highly volatile (should all evaporate within 1 – 2 days)
* High concentrations of toxic (soluble) compounds
* Result: Localized, severe impacts to water column and intertidal resources
* Duration of impact is a function of the resource recovery rate
* No dispersion necessary

SHORELINE TYPE CODES

1 - Seawalls and piers
2 - Exposed wave-cut platforms
3 - Fine-grained sand beaches
4 - Coarse-grained sand beaches
5 - Mixed sand and gravel (or shell) beaches
6 - Gravel beaches and riprap structures
7 - Exposed tidal flats
8 - Sheltered rocky shores
9 - Sheltered tidal flats
10- Fringing and extensive salt marshes

COUNTERMEASURE	SHORELINE TYPES									
	1	2	3	4	5	6	7	8	9	10
1) No Action										
2) Manual Removal										
3) Passive Collection (Sorbents)										
4) Debris Removal										
5) Trenching										
6) Sediment Removal										
7) Ambient Water Flooding (Deluge)										
8) Ambient Water Washing										
a) Low Pressure (< 50 psi)										
b) High Pressure (< 100 psi)										
9) Warm Water Washing/Mod.-High Pressure										
10) Hot Water/High Pressure Washing										
11) Slurry Sand Blasting										
12) Vacuum										
13) Sediment Reworking †										
14) Excavation, Cleansing, and Replacement										
15) Cutting Vegetation										
16) Chemical Treatment †										
a) Oil Stabilization with Elastomizers										
b) Protection of Beaches										
c) Cleaning of Beaches										
17) *In situ* Burning of Shorelines †										
18) Nutrient Enhancement †										
19) Microbial Addition †										

† - Requires RRT approval
R - Recommended - may be preferred alternative
C - Conditional

Do Not Use

This countermeasure advisability matrix is only a general guide for removal of oil from shoreline substrates. It must be used in conjunction with the entire Shoreline Countermeasures Manual plus field observations and scientific advice. The countermeasures listed are not necessarily the best under all circumstances, and any listed technique may need to be used in conjunction with other techniques (including ones not listed herein). The Federal On-Scene Coordinator (FOSC) or the state OSC operating with the FOSC's authorization has the responsibility for and authority to determine which countermeasure(s) are appropriate for the various situations encountered. Selection of countermeasures is based on the degree of oil contamination, the shoreline type, and the presence of sensitive resources. Extremely sensitive areas are limited to manual cleanup countermeasures.

Shoreline Countermeasure Matrix

Light Oils (Diesel, No. 2 Fuel Oils, Light Crudes)

* Moderately volatile; will leave residue (up to 1/3 of spilled amount)
* Moderate concentrations of toxic (soluble) compounds
* Will "oil" intertidal resources with long-term contamination potential
* Has potential for subtidal impacts (dissolution, mixing, sorption onto suspended sediments)
* No dispersion necessary
* Cleanup can be very effective

SHORELINE TYPE CODES

1 - Seawalls and piers
2 - Exposed wave-cut platforms
3 - Fine-grained sand beaches
4 - Coarse-grained sand beaches
5 - Mixed sand and gravel (or shell) beaches
6 - Gravel beaches and riprap structures
7 - Exposed tidal flats
8 - Sheltered rocky shores
9 - Sheltered tidal flats
10 - Fringing and extensive salt marshes

COUNTERMEASURE	SHORELINE TYPES									
	1	2	3	4	5	6	7	8	9	10
1) No Action										
2) Manual Removal										
3) Passive Collection (Sorbents)										
4) Debris Removal										
5) Trenching										
6) Sediment Removal										
7) Ambient Water Flooding (Deluge)										
8) Ambient Water Washing										
a) Low Pressure (< 50 psi)										
b) High Pressure (< 100 psi)										
9) Warm Water Washing/Mod.-High Pressure										
10) Hot Water/High Pressure Washing										
11) Slurry Sand Blasting										
12) Vacuum										
13) Sediment Reworking †										
14) Excavation, Cleansing, and Replacement										
15) Cutting Vegetation *										
16) Chemical Treatment †										
a) Oil Stabilization with Elastomizers										
b) Protection of Beaches										
c) Cleaning of Beaches										
17) *In situ* Burning †										
18) Nutrient Enhancement †										
19) Microbial Addition †										

† - Requires RRT approval
R - Recommended - may be preferred alternative
C - Conditional

 Do Not Use

This countermeasure advisability matrix is only a general guide for removal of oil from shoreline substrates. It must be used in conjunction with the entire Shoreline Countermeasures Manual plus field observations and scientific advice. The countermeasures listed are not necessarily the best under all circumstances, and any listed technique may need to be used in conjunction with other techniques (including ones not listed herein). The Federal On-Scene Coordinator (FOSC) or the state OSC operating with the FOSC's authorization has the responsibility for and authority to determine which countermeasure(s) are appropriate for the various situations encountered. Selection of countermeasures is based on the degree of oil contamination, the shoreline type, and the presence of sensitive resources. Extremely sensitive areas are limited to manual cleanup countermeasures.

Shoreline Countermeasure Matrix

Medium Oils (Most Crude Oils)

* About 1/3 will evaporate within 24 hours
* Maximum water-soluble fraction is 10 – 100 ppm
* Oil contamination of intertidal areas can be severe/long term
* Impact to waterfowl and fur-bearing mammals can be severe
* Chemical dispersion is an option within 1 – 2 days
* Cleanup most effective if conducted quickly

SHORELINE TYPE CODES

1 - Seawalls and piers
2 - Exposed wave-cut platforms
3 - Fine-grained sand beaches
4 - Coarse-grained sand beaches
5 - Mixed sand and gravel (or shell) beaches
6 - Gravel beaches and riprap structures
7 - Exposed tidal flats
8 - Sheltered rocky shores
9 - Sheltered tidal flats
10- Fringing and extensive salt marshes

COUNTERMEASURE	SHORELINE TYPES									
	1	2	3	4	5	6	7	8	9	10
1) No Action										
2) Manual Removal										
3) Passive Collection (Sorbents)										
4) Debris Removal										
5) Trenching										
6) Sediment Removal										
7) Ambient Water Flooding (Deluge)										
8) Ambient Water Washing										
a) Low Pressure (< 50 psi)										
b) High Pressure (< 100 psi)										
9) Warm Water Washing/Mod.-High Pressure										
10) Hot Water/High Pressure Washing										
11) Slurry Sand Blasting										
12) Vacuum										
13) Sediment Reworking †										
14) Excavation, Cleansing, and Replacement										
15) Cutting Vegetation *										
16) Chemical Treatment †										
a) Oil Stabilization with Elastomizers										
b) Protection of Beaches										
c) Cleaning of Beaches										
17) *In situ* Burning †										
18) Nutrient Enhancement †										
19) Microbial Addition †										

† - Requires RRT approval
R - Recommended - may be preferred alternative
C - Conditional

 Do Not Use

This countermeasure advisability matrix is only a general guide for removal of oil from shoreline substrates. It must be used in conjunction with the entire Shoreline Countermeasures Manual plus field observations and scientific advice. The countermeasures listed are not necessarily the best under all circumstances, and any listed technique may need to be used in conjunction with other techniques (including ones not listed herein). The Federal On-Scene Coordinator (FOSC) or the state OSC operating with the FOSC's authorization has the responsibility for and authority to determine which countermeasure(s) are appropriate for the various situations encountered. Selection of countermeasures is based on the degree of oil contamination, the shoreline type, and the presence of sensitive resources. Extremely sensitive areas are limited to manual cleanup countermeasures.

Shoreline Countermeasure Matrix

Heavy Oils (Heavy Crude Oils, No. 6 fuel, Bunker C)

* Heavy oils with little or no evaporation or dissolution
* Water-soluble fraction likely to be <10 ppm
* Heavy contamination of intertidal areas likely
* Severe impacts to waterfowl and fur-bearing mammals (coating and ingestion)
* Long-term contamination of sediments possible
* Weathers very slowly
* Dispersion seldom effective
* Shoreline cleanup difficult under all conditions

SHORELINE TYPE CODES

1 - Exposed wave-cut cliffs
2 - Exposed wave-cut platforms
3 - Fine-grained sand beaches
4 - Coarse-grained sand beaches
5 - Mixed sand and gravel (or shell) beaches
6 - Gravel beaches and riprap structures
7 - Exposed tidal flats
8 - Sheltered rocky shores
9 - Sheltered tidal flats
10 - Fringing and extensive salt marshes

COUNTERMEASURE	SHORELINE TYPES									
	1	2	3	4	5	6	7	8	9	10
1) No Action										
2) Manual Removal										
3) Passive Collection (sorbents)										
4) Debris Removal										
5) Trenching										
6) Sediment Removal										
7) Cold Water Flooding (deluge)										
8) Cold Water Washing										
a) Low Pressure (< 50 psi)										
b) High Pressure (< 100 psi)										
9) Warm Water Washing/Mod.-High Pressure										
10) Hot Water/High Pressure Washing										
11) Slurry Sand Blasting										
12) Vacuum										
13) Sediment Reworking †										
14) Excavation, Cleansing, and Replacement										
15) Cutting Vegetation *										
16) Chemical Treatment †										
a) Oil Stabilization with Elastomizers										
b) Protection of Beaches										
c) Cleaning of Beaches										
17) *In situ* Burning †										
18) Nutrient Enhancement †										
19) Microbial Addition †										

*† - Requires RRT approval
R - Recommended - may be preferred alternative
C - Conditional

Do Not Use

This countermeasure advisability matrix is only a general guide for removal of oil from shoreline substrates. It must be used in conjunction with the entire Shoreline Countermeasures Manual plus field observations and scientific advice. The countermeasures listed are not necessarily the best under all circumstances, and any listed technique may need to be used in conjunction with other techniques (including ones not listed herein). The Federal On-Scene Coordinator (FOSC) or the state OSC operating with the FOSC's authorization has the responsibility for and authority to determine which countermeasure(s) are appropriate for the various situations encountered. Selection of countermeasures is based on the degree of oil contamination, the shoreline type, and the presence of sensitive resources. Extremely sensitive areas are limited to manual cleanup countermeasures.

5 Treatment Methods Not Requiring Regional Response Team Consideration

The following section lists and describes those techniques that have been approved by the Regional Response Team (RRT), Local Response Team, and/or the Area Committee. Methods and equipment currently in use for these approved shoreline treatment methods are described in some detail below. These methods, when used according to the guidelines in this manual, may be used on most sites as part of the OSC-directed response. It should be noted that some of these methods may require other authorizations or permits before work begins. Currently approved methods are:

1 No Action
2 Manual Removal
3 Passive Collection (Sorbents)
4 Debris Removal
5 Trenching
6 Sediment Removal
7 Ambient-Water Flooding (Deluge)
8a Ambient-Water/Low-Pressure Washing
8b Ambient-Water/High-Pressure Washing
9 Warm-Water/Moderate-to-High-Pressure Washing
10 Hot-Water/High-Pressure Washing
11 Slurry Sand Blasting
12 Vacuum
13 Sediment Reworking *
14 Sediment Removal, Cleansing, and Replacement *
15 Cutting Vegetation *

* May require special consideration

1. No Action

Objective

No attempt is made to remove stranded oil, because there is no proven effective method for cleanup, or it is determined that cleanup will be more harmful to the habitat than leaving the oil in place.

Description

No action is taken. However, the OSC continues to monitor the incident.

Applicable Shoreline Types

Can be used on all shoreline types.

When To Use

If the shoreline is extremely remote or inaccessible, when natural removal rates are very fast, or cleanup actions will do more harm than leaving the oil to be removed naturally.

Biological Constraints

This method may be inappropriate for areas where high numbers of mobile animals (birds, marine mammals, crabs, etc.) use the intertidal zone or adjacent nearshore waters.

Environmental Effects

Intertidal — The same as the oil.

Subtidal — The same as the oil.

2. Manual Removal

Objective

Removing stranded surface oil with hand tools and manual labor.

Description

Removing surface oil and oily debris by manual means (hands, rakes, shovels, etc.) and placing in containers for removal from the shoreline. No mechanized equipment is used.

Applicable Shoreline Types

Can be used on all shoreline types.

When To Use

Generally used on shorelines where the oil can be easily removed by non-mechanical means. Most appropriate for light to moderate oiling conditions.

Biological Constraints

Foot traffic over sensitive areas (shellfish beds, tidal flats, bird nesting areas, turtle nesting beaches, marshes, etc.) is to be restricted. May be periods when shoreline access is restricted (e.g., bird nesting, turtle nesting).

Environmental Effects

Intertidal — Minimal if surface disturbance by cleanup activities and work force movement is limited.

Subtidal — None.

3. Passive Collection (Sorbents)

Objective

Removal of oil by adsorption onto oleophilic material placed in the intertidal zone.

Description

Sorbent material is placed on the surface of the shoreline substrate allowing it to absorb oil as it is released by tidal or wave action. Oil removal is dependent on the capacity of the particular sorbent, energy available for lifting oil off the shoreline, and degree of weathering.

Applicable Shoreline Types

Can be used on any shoreline type, especially riprap and on intertidal vegetation.

When to Use

When the shoreline oil is mobile and transport of oil is expected on or off the site. The oil must be of a viscosity and thickness to be released by the substrate and absorbed by the sorbent. Often used as a secondary treatment method after gross oil removal, and along sensitive shorelines where access is restricted.

Biological Constraints

None, although this method can be slow, thus allowing oil to remain in critical habitats during sensitive periods of time.

Environmental Effects

Intertidal — There may still be significant amounts of oil remaining on the shoreline after the sorbents are no longer effective. Also, if all the sorbents are not recovered, they will become oily debris which does not degrade.

Subtidal — None.

4. Debris Removal

Objective

Removal of contaminated debris and seagrass wrack.

Description

Manual or mechanical removal of debris from the upper beach face and the zone above high tide beyond the normal wash of waves.

Applicable Shoreline Types

Can be used on any shoreline type where safe access is allowed.

When to Use

When driftwood, marine debris, and seagrass wrack are heavily contaminated and either a potential source of chronic oil release, an aesthetic problem, or a source of contamination for other organisms on the shoreline.

Biological Constraints

Disturbance to adjacent upland areas should be minimized. Foot traffic over sensitive intertidal areas (tidal flats, bird nesting areas, turtle nesting beaches, marshes, etc.) is to be restricted. May be periods when shoreline access is restricted (e.g., bird nesting, turtle nesting).

Environmental Effects

Intertidal — None.

Subtidal — None.

5. Trenching

Objective

Remove subsurface oil from permeable substrates.

Description

Dig trenches to the depth of the oil and remove oil floating on the water table by vacuum pump or super sucker. Water flooding or high-pressure spraying at ambient temperatures can be used to flush oil to the trench.

Applicable Shoreline Types

Can be used on beaches ranging in grain size from fine sand to gravel. Trenching should not be used in areas where there are known cultural resources in the intertidal zone.

When To Use

When large quantities of oil penetrate deeply into permeable sediments and cannot be removed by surface flooding. The oil must be liquid enough to flow at ambient temperatures.

Biological Constraints

Trenches should not be dug in the lower intertidal when seagrasses and organisms are abundant.

Environmental Effects

Intertidal — On gravel beaches, there may be a period of beach instability as the sediments are redistributed after the trenches are filled in.

Subtidal — None.

6. Sediment Removal

Objective

Removal of surface oiled sediments.

Description

Oiled sediments are removed by either manual use of hand tools or mechanical use of various kinds of motorized equipment. The oiled material must be transported and disposed of off-site.

Applicable Shoreline Types

Can be used on any shoreline with surface sediments. On rocky coasts, only manual removal is feasible. When using equipment on beaches, special supervision is required to minimize sediment removal. Sediment removal should not be used in areas where there are known cultural resources in the intertidal zone.

When to Use

When only very limited amounts of oiled sediments have to be removed. Should not be considered where beach erosion may result. Care should be taken to remove the sediments only to the depth of oil penetration, which can be difficult with heavy equipment.

Biological Constraints

Excavating equipment must not intrude upon sensitive habitats or areas of known cultural resources in the intertidal zone. Only the upper intertidal and supratidal areas should be considered for sediment removal to minimize disturbance of biological communities in the subtidal, particularly when coral reefs and seagrass beds occur very close to shore. There may be site-specific constraints limiting

placement of equipment and temporary sediment storage piles in the backshore. Replaced material must be free of oil and toxic substances.

Environmental Effects

Intertidal — The equipment is heavy, and required support personnel is extensive. May be detrimental if excessive sediments are removed without replacement. All organisms resident in the beach will be affected, though the need for removal of the oil may be determined to be the best overall alternative.

Subtidal — Release of oil and fine-grained oily sediments to the water during sediment removal activities and tidal flushing of the excavated beach surface.

7. Ambient-Water Flooding (Deluge)

Objective

To wash surface oil and oil from crevices and rock interstices to water's edge for collection.

Description

A large diameter header pipe is placed parallel to the shoreline above the oiled area. A flexible perforated header hose is used during deluge of intertidal shorelines to better conform to their profiles. Ambient seawater is pumped through holes in the header pipes and flows down the beach face to the water. On porous beaches, water flows through the substrate pushing loose oil ahead of it (or floats oil to the water's surface) then transports the oil down slope for pickup. Flow is maintained as long as necessary to remove the majority of free oil. Oil is trapped by booms and picked up with a skimmer or other suitable equipment.

Applicable Shoreline Types

Beaches with sediments coarser than sand, and gently sloping rocky shorelines. Generally not applicable to mud, sand, vegetated, or steep rocky shorelines.

When to Use

On heavily oiled shorelines when the oil is still fluid and loosely adhering to the substrate; and where oil has penetrated into gravel beaches. This method is frequently used in combination with other washing techniques (low or high pressure, ambient or warm water).

Biological Constraints

Not appropriate at creek mouths. Where seagrass beds or tidal flats occur adjacent to the shoreline, flooding should be restricted to tidal stages when these sensitive habitats are under water, to prevent secondary oiling.

Environmental Effects

Intertidal — Habitat may be physically disturbed and smothered as sand and gravel components are washed down slope. Organisms may be flushed into lower tidal zones.

Subtidal — Oiled sediment may be transported to shallow subtidal areas, contaminating them and burying benthic organisms and seagrasses.

8a. Ambient-Water/Low-Pressure Washing

Objective

Remove liquid oil that has adhered to the substrate or man-made structures, pooled on the surface, or become trapped in vegetation.

Description

Low-pressure washing (<50 psi) with ambient seawater sprayed with hoses is used to flush oil to the water's edge for pickup. Oil is trapped by booms and picked up with skimmers or sorbents. Can be used with a deluge system on beaches to prevent released oil from re-adhering to the substrate.

Applicable Shoreline Types

On heavily oiled gravel beaches, riprap, and seawalls where the oil is still fresh and liquid. Also, in marshes and mangroves where free oil is trapped.

When to Use

Where adhered oil is still fresh and must be removed due to continued release of oil.

Biological Constraints

May need to restrict use of flushing to certain tidal elevations so that the oil/water effluent does not drain across sensitive low-tide and shallow subtidal habitats. In marshes, use only at high tide and either from boats or the high-tide line to prevent foot traffic in vegetation.

Environmental Effects

Intertidal — If containment methods are not sufficient, contamination may be flushed into lower intertidal zone.

Subtidal — Oiled sediment may be transported to shallow subtidal areas, contaminating them and burying benthic organisms and seagrasses.

8b. Ambient-Water / High-Pressure Washing

Objective

Remove oil that has adhered to hard substrates or man-made structures.

Description

Similar to low-pressure washing except that water pressure is up to 100 psi. High-pressure spray will better remove oil that has adhered to rocks. When water volumes are low, workers may need to place sorbents directly below treatment areas to prevent the released oil from adhering to downstream sediments.

Applicable Shoreline Types

Riprap and seawalls. Can be used to flush floating oil or loose oil out of tide pools and between crevices on riprap.

When To Use

When low-pressure washing is not effective for removal of adhered oil, which must be removed due to continued release of oil. When directed water jet can remove oil from hard-to-reach sites. To remove oil from man-made structures for aesthetic reasons.

Biological Constraints

May need to restrict use of flushing to certain tidal elevations so that the oil / water effluent does not drain across sensitive low-tide and shallow subtidal habitats.

Environmental Effects

Intertidal — Removes many organisms on the surface. May drive oil deeper into the substrate or cause sediment erosion of the finer-grained fraction if water jet is improperly applied. If containment methods are not sufficient, contamination may be flushed into lower intertidal zone.

Subtidal — Oiled sediment may be transported to shallow subtidal areas, contaminating them and burying benthic organisms and seagrasses.

9. Warm-Water / Moderate-to-High-Pressure Washing

Objective

Mobilize thick and weathered oil adhered to rock surfaces prior to flushing it to the water's edge for collection.

Description

Heated seawater (ambient to 90°F) is applied at moderate-to-high pressure to mobilize weathered oil that has adhered to rocks. The warm water may be sufficient to flush the oil down the beach. If not, "deluge" flooding and additional low- or high-pressure washing can be used to float the oil to the water's edge for pickup. Oil is trapped by booms and picked up with skimmers or sorbents.

Applicable Shoreline Types

Gravel beaches, riprap, and seawalls that are heavily oiled. However, large volumes of water or a deluge system will be needed to prevent the oil from being driven in deeper into the sediments.

When To Use

When the oil has weathered to the point that low-pressure washing with ambient water is not effective for removal of adhered oil, which must be removed due to continued release of oil. To remove oil from man-made structures for aesthetic reasons.

Biological Constraints

Must restrict use to certain tidal elevations so that the oil / water effluent does not drain across sensitive low-tide habitats (damage can result from exposure to oil, oiled sediments, and warm water). Should be restricted adjacent to stream mouths, tide pool communities, and similar rich intertidal communities.

Environmental Effects

Intertidal — Can kill or remove most organisms. If containment methods are not sufficient, contamination may be flushed into lower intertidal zones that would otherwise not be oiled. May drive oil deeper into the substrate or cause sediment erosion of the finer-grained fraction if water jet is improperly applied.

Subtidal — Oiled sediment may be transported to shallow subtidal areas, contaminating them and burying benthic organisms and seagrasses.

10. Hot-Water / High-Pressure Washing

Objective

Dislodge trapped and weathered oil from inaccessible locations and surfaces not amenable to mechanical removal.

Description

Water heaters mounted offshore on barges or small land-based units heat water to temperatures from 90°F up to 170°F, which is usually sprayed by hand with high-pressure wands. Used without water flooding, this procedure requires immediate use of vacuum (vacuum trucks or super suckers) to remove the oil / water runoff. With a deluge system, the oil is flushed to the water's surface for collection with skimmers or sorbents.

Applicable Shoreline Types

Gravel beaches, riprap, and seawalls that are heavily oiled. However, large volumes of water or a deluge system will be needed to prevent the oil from being driven in deeper into the sediments.

When To Use

When the oil has weathered to the point that even warm water at high pressure is not effective for removal of adhered oil, which must be removed due to continued release of oil. To remove oil from man-made structures for aesthetic reasons.

Biological Constraints

Restrict use to certain tidal elevations so that the oil / water effluent does not drain across sensitive low-tide habitats (damage can result from exposure to oil, oiled sediments, and hot water). Should be restricted near stream mouths, tide pool communities, etc. Released oil must be recovered to prevent further oiling of adjacent environments.

Environmental Effects

Intertidal — All attached organisms in the direct spray zone will be removed or killed, and significant mortality of the lower intertidal communities will result even when used properly. Where the intertidal community is rich, the tradeoff between damage to the intertidal community from the hot-water washing versus potential damage from leaving the oil has to be weighed. May drive oil deeper into the substrate or cause sediment erosion of the finer-grained fraction if water jet is improperly applied.

Subtidal — Oiled sediment may be transported to shallow subtidal areas, contaminating them and burying benthic organisms and seagrasses.

11. Slurry Sand Blasting

Objective

Remove heavy residual oil from solid substrates.

Description

Use of sandblasting equipment to remove oil from the substrate. May include recovery of used (oiled) sand in some cases.

Applicable Shoreline Types

Seawalls and riprap. Equipment can be operated from boat or land.

When to Use

When heavy oil residue is remaining on the shoreline, which needs to be cleaned for aesthetic reasons, and even hot-water wash is not effective.

Biological Constraints

Not to be used in areas of high biological abundance on the shoreline directly below or adjacent to the structures.

Environmental Effects

Intertidal — Complete destruction of all organisms in the intertidal zone.

Subtidal — Possible smothering of subtidal organisms with sand. When the used sand is not recovered, introduces oiled sediments into the subtidal habitat.

12. Vacuum

Objective

Remove free oil pooled on the substrate or from the water's surface in sheltered areas.

Description

Use of a vacuum unit with a suction head to recover free oil. The equipment can range from small portable units that fill individual 55-gallon drums to large supersuckers that are truck-mounted and can lift large rocks. Can be used with water spray systems to flush the oil towards the suction head.

Applicable Shoreline Types

Can be used on any shoreline type if accessible. May be mounted offshore on barges, onshore on trucks, or as individual units on boats or ashore at low tide.

When to Use

When free, liquid oil is stranded on the shoreline (usually along the high-tide line) or trapped in vegetation that is readily accessible.

Biological Constraints

Special restrictions should be identified for areas where foot traffic and equipment operation should be limited, such as mangrove forests. Operations in wetlands are to be very closely monitored, with a site-specific list of restrictions.

Environmental Effects

Intertidal — Minimal impacts if used properly and minimal substrate is removed.
Subtidal — None.

13. Sediment Reworking

Objective

Rework oiled sediments to break up the oil deposits, increase its surface area, and mix deep subsurface oil layers that will expose the oil to natural removal processes and enhance the rate of oil degradation.

Description

Beach sediments are rototilled or otherwise mechanically mixed with the use of heavy equipment on sand or gravel beaches. The oiled sediments in the upper beach area may also be relocated lower on the beach to enhance natural cleanup during reworking by wave activity (berm relocation).

Applicable Shoreline Types

Should be used only on beaches exposed to significant wave activity. Tilling-type activities work best on beaches with a significant sand fraction; large equipment can be used to relocate sediments up to boulder size. Sediment reworking should not be used in areas where there are known cultural resources in the intertidal zone.

When to Use

On beaches with significant amounts of subsurface oil, where sediment removal is unfeasible (due to erosion concerns or disposal problems); also where surface oil deposits have started to form pavements or crusts.

Biological Constraints

Could not be used on beaches near shellfish-harvest or fish-spawning areas, or near bird nesting or concentration areas because of the potential for constant release of oil and oiled sediments. Sediment reworking should be restricted to the intertidal, to prevent disturbance of the biological communities in the shallow subtidal.

Environmental Effects

Intertidal — Due to the mixing of oil into sediments, this process could further expose organisms living below the original layer of oil. Repeated mixing over time could delay the reestablishment of organisms. Relocated sediments would bury and kill organisms. There may be a period of beach instability as the relocated sediments are redistributed.

Subtidal — There is a potential for release of contaminated sediments to the nearshore subtidal habitats.

14. Sediment Removal, Cleansing, and Replacement

Objective

To remove and clean oiled sediments, then replace them on the beach.

Description

Oiled sediments are excavated using heavy equipment on the beach at low tide. The sediments are loaded into a container for washing. Cleansing methods include hot-water wash or physical agitation with a cleansing solution. After the cleansing process, the rinsed materials are returned to the original area. Cleaning equipment must be placed close to beaches to reduce transportation problems.

Applicable Shoreline Types

Sand- to boulder-sized beaches, depending on the limitations of the cleanup equipment. The beaches must be exposed to wave activity, so that the replaced sediments can be reworked into a natural distribution. Sediment removal should not be used in areas where there are known cultural resources in the intertidal zone.

When to Use

Applicable on beaches with large amounts of subsurface oil, where permanent removal of sediment is undesired and other cleanup techniques are likely to be ineffective.

Biological Constraints

Excavating equipment must not intrude upon sensitive habitats. Only the supratidal and intertidal areas should be considered. There may be site-specific constraints limiting placement of temporary sediment storage piles. Replaced material must be free of oil and toxic substances. The washing must not change the grain size of the replaced material, either by removal of fines or excessive breakage of friable sediments.

Environmental Effects

Intertidal — All resident organisms will be affected, though the need for removal of the oil may be determined to be the best overall solution. Equipment can be heavy, large, and noisy; disrupting wildlife. Transportation to site may entail aircraft, land vehicles, or barges, contributing to environmental disruption. There may be a period of beach instability as the replaced sediments are redistributed.

Subtidal — May release oil and fine-grained oily sediments into the water during excavation and tidal flushing of beach sediments and exposed excavations. Adjacent seagrass and coral reef communities may be at risk.

15. Cutting Vegetation

Objective

Removal of oiled vegetation to prevent oiling of wildlife.

Description

Manual cutting of oiled vegetation using weed eater or by hand, and removal of cut vegetation with rakes. The cut vegetation is bagged immediately for disposal.

Applicable Shoreline Types

Marshes composed of emergent, herbaceous vegetation; oiled seagrass blades. Mangrove forests are not included.

When to Use

Use when the risk of oiled vegetation contaminating wildlife is greater than the value of the vegetation that is to be cut, and there is no less destructive method to remove or reduce the risk to acceptable levels.

Biological Constraints

Strict monitoring of the operations must be conducted to minimize the degree of root destruction and mixing of oil deeper into the sediments. Access to bird nesting areas should be restricted during nesting seasons.

Environmental Effects

Intertidal — Removal of the vegetation will result in loss of habitat for many animals. Cut marsh areas will have reduced plant growth for up to two years. Trampled areas (which are inevitable) will recover much slower. Along exposed shorelines, vegetation may not regrow, resulting in erosion and permanent loss of the habitat.

Subtidal — Long-term impacts would include increased sediment load in the subtidal area as a result of increased erosion in the intertidal area. For removal of

oiled seagrass blades, disruption of the roots can result in total destruction of the bed.

6 Treatment Methods Requiring Regional Response Team Approval

Research and development is ongoing for both new and improved oil spill treatment methods. Various chemical and biological degradation techniques are currently being tested for effectiveness and toxicity, and they may be approved for use in certain situations. Methods considered to be of potential use in this area are described below.

16a. Chemical Oil Stabilization with Elastomizers

Objective

Solidify or gelatinize oil on the water's surface or a beach to keep it from spreading or escaping, and to speed recovery rate and efficiency.

Description

Chemical agent enhancing polymerization of the hydrocarbon molecules applied by semi-liquid spray or as a dry chemical onto the oil in the proper dosage. Depending on the nature and concentration of the polymerizing agent, the oil can be rendered viscoelastic, but still fluid, gelatinous, or semisolid. The primary purpose is to stabilize the oil, keeping it from spreading or escaping, causing oiling elsewhere. May reduce the solubility of the light (and more toxic) fractions, by locking them into the polymer. This reduces both air and water exposure. Depending on the beach type and equipment used, recovery may be enhanced.

Applicable Shoreline Types

Suitable on shorelines of low permeability where heavy oil has pooled on the surface, except vegetated shorelines.

When to Use

When heavy concentrations of liquid oil are on the substrate and adjacent water body, and physical removal can not be completed prior to the next tide so that the oil is likely to move to a more sensitive shoreline type. Should be used in conjunction with booming or other physical containment.

Biological Constraints

Not suitable for vegetated or riprap shore types. Should be avoided when birds or other wildlife that may be more adversely impacted by the congealed oil can not be kept away from the treated shoreline. The congealed oil may stick to vegetation and wildlife, increasing physical damage to both. On riprap the congealed oil may remain in crevices where it may hamper recovery and prolong the release of sheens.

Environmental Effects

May enhance the smothering effect of oil on intertidal organisms. Thus, the treatment should be considered only for heavily oiled beaches where smothering effects are already maximal. The congealed oil may stick to vegetation and wildlife increasing physical damage, such as impaired flight or thermoregulation in birds whose feathers become oiled.

16b. Chemical Protection of Beaches

Objective

Pretreat shoreline to prevent oil from adhering to the substrate.

Description

Certain types of water-based chemicals, some of which are similar in composition to dispersants, are applied to beaches in advance of the oil.

Applicable Shoreline Types

Coarse- and fine-grained sand beaches, seawalls and piers (particularly piers or waterfront facilities that are of historical significance), wave-cut platforms, and riprap.

When to Use

When oil is projected to impact an applicable shoreline, particularly those that have high recreational or aesthetic value.

Biological Constraints

May not be suitable for nutrient-rich environments, particularly in confined waters. The toxicity of shoreline treatment products is reportedly much less than that of oil, but the toxicity of each product should be evaluated prior to consideration for use.

Environmental Effects

The long-term environmental effects of these procedures are unknown. A toxic effect of the chemical can be anticipated. Additionally, the nutrient load to nearshore and interstitial waters may lead to eutrophication. Whether the predicted reduced residence time of the oil on the beach will increase the survival rate for sessile and interstitial organisms is unknown.

16c. Chemical Cleaning of Beaches

Objective

To increase the efficiency of oil removal from contaminated areas.

Description

Special formulations, which can be characterized as weak dispersants, are applied to the substrate, as a presoak and/or flushing solution, to soften weathered or heavy oils to aid in the efficiency of flushing treatment methods. The intent is to be able to lower the temperature and pressure required to mobilize the oil from the substrate.

Applicable Shoreline Types

On any shoreline where deluge and water flushing procedures are applicable.

When to Use

When the oil has weathered to the point where it will not flow using warm to hot water. This approach may be most applicable where flushing decreases in effectiveness as the oil weathers.

Biological Constraints

Will require extensive biological testing for toxicity and water quality sampling prior to receiving approval for use. The concern is that the treated oil will be dispersed in the water column, and thus impact water column and subtidal organisms. Field tests will be required to show that use of a beach cleaner does not reduce overall recoverability of the oil. Use may be restricted where suspended sediment concentrations are high, adjacent to wetlands and tidal flats, and near sensitive subtidal resources.

Environmental Effects

If more oil is dispersed into the water column, there could be more oil sorbed onto suspended sediments and transferred to subtidal habitats, particularly along sheltered shorelines.

17. In Situ Burning of Shorelines

Objective

Removal of oil from the shoreline by burning.

Description

Oil on the shoreline is burned, usually when it is on a combustible substrate such as vegetation, woody material, and other debris. Oil can be burned off of nonflammable substrates with the aid of a burn promoter.

Applicable Shoreline Types

On any shoreline type except tidal flats and mangroves.

When to Use

Early in the spill event, after ensuring that the product is ignitable.

Biological Constraints

Should only be considered for use in the upper intertidal or supratidal zones since destruction of plants and animals from heat and burn promoters will be extensive. This technique is subject to restrictions and permit requirements established by federal, state and local laws. It should not be used to burn PCBs, wastes containing more than 1,000 parts per million (ppm) of halogenated solvents, or other substances regulated by the U. S. Environmental Protection Agency (EPA).

Environmental Effects

Little is known about the relative effects of burning oiled wetlands compared to other techniques or natural recovery. Burning may cause significant air pollution, which must be considered when weighing the potential benefits and risks of the technique. The combustion products may travel great distances before deposition.

18. Nutrient Enhancement

Objective

To speed the rates of natural microbial degradation of oil by addition of nutrients (specifically nitrogen and phosphorus). Microbial biodegradation is the conversion by microorganisms of dissolved and dispersed hydrocarbons into oxidized products via various enzymatic reactions. Some hydrocarbons are converted to carbon dioxide and cell material, while others are partially oxidized and/or left unaltered as a residue.

Description

Nutrients are applied to the shoreline in one of several methods: soluble inorganic formulations that are dissolved in water and applied as a spray at low tide, requiring frequent applications; slow-release formulations that are applied as a solid to the intertidal zone and designed to slowly dissolve; and oleophilic formulations that adhere to the oil itself, thus they are sprayed directly on the oiled areas.

Applicable Shoreline Types

Could be used on any shoreline type where safe access is allowed.

When to Use

On moderately to heavily oiled shorelines, after other techniques have been used to remove as much oil as possible; on lightly oiled shorelines where other techniques are not effective; and where nutrients are a limiting factor in natural degradation. Potentially for the treatment of subsurface oil.

Biological Constraints

Not applicable in shallow water, poorly flushed, restricted embayments where nutrient overloading may lead to eutrophication, or where toxicity of nutrients, particularly ammonia, is of concern. There must be no risk of oxygen depletion. Use is to be restricted adjacent to stream mouths, tide pools, or other rich intertidal communities. Contact toxicity of oleophilic formulations may restrict areas of direct application. Bioassay test results should be carefully evaluated, as other chemicals in the formulations could be toxic to aquatic organisms.

Environmental Effects

Acute toxicity from direct application to intertidal organisms may result from different formulations. Also, toxic effects may occur from the release of ammonia to the water column and interstitial water. There may be localized zones of oxygen depletion, particularly in the interstitial water.

19. Microbial Addition

Objective

To speed the rates of natural microbial degradation of oil by addition of nutrients and microbial products. Microbial biodegradation is the conversion by microorganisms of dissolved and dispersed hydrocarbons into oxidized products via various enzymatic reactions. Some hydrocarbons are converted to carbon dioxide and cell material, while others are partially oxidized and/or left unaltered as a residue.

Description

Formulations containing hydrocarbon-degrading microbes and fertilizers are added to the oiled area. The argument is made that indigenous organisms will be killed by the oil, so new microbial species need to be added to begin the process of biodegradation. To date, microbial addition has not been shown to work better than fertilizer alone in field tests.

Applicable Shoreline Types

Could be used on any shoreline type where safe access is allowed.

Biological Constraints

Not applicable in shallow water, poorly flushed, restricted embayments where nutrient overloading may lead to eutrophication, or where toxicity of nutrients, particularly ammonia, is of concern. There must be no risk of oxygen depletion. Use is to be restricted adjacent to stream mouths, tide pool communities, etc. Bioassay test results should be carefully evaluated, as other chemicals in the formulation could be toxic to aquatic organisms.

Environmental Effects

Yet to be evaluated for full-scale field applications. There is a potential for the introduction of pathogens from contaminated formulations.

Appendix A

Guidelines for Treatment Operations

General Guidelines

Ensure familiarity and compliance with approved treatment methods, approved shoreline segment work plans, advisories, and special instructions. Restrict all access to wetlands and tidal flats, except with special authorization.

Conditions to avoid

- Treatment techniques (such as high pressure and hot water) that dislodge intertidal vegetation and invertebrates, e.g., mussels, barnacles, snails
- Clearing marshes and vegetated shorelines (the presence of algae does not characterize a vegetated shoreline)

Actions to encourage

- Boom off mud / grass flat adjacent to treatment areas to prevent further contamination.
- Boom off tidal creeks to prevent further contamination.
- Minimize impact to uncontaminated lower intertidal zones, including:
  - land crews during tides that cover the lower intertidal zone
  - avoid high- / low-pressure washing where possible
  - work heavily oiled upper beach zone hen lower intertidal zones are covered by high tides
  - employ sorbents along riprap and below oiled upper beach to protect lower intertidal zone from oiling

Ensure that all signs of human activity are removed when cleanup is completed. Ensure that all trash and wastes are removed daily:

- Oil trapped in booms must be picked up before the next tide cycle
- All food and associated trash must be removed each day to minimize attracting wildlife into contaminated areas

Guidelines Specific to Biological Resources

Advisories and special instructions may address:

- bird concentration areas (nesting sites, colonies, rookeries, etc.)
- live / dead animal collection policy
- protection of cultural resources
- marine mammal haulouts
- collection of eagle feathers and marine mammal parts
- cutting bull kelp
- cutting oiled fucus

Appendix B includes existing “best management practices” for specific issues addressed during previous spills, which can be used as the basis for developing regional guidelines.

Appendix B

Best Management Practices

Specialized Areas of Concern - National

(The following notices are provided as guidelines.)

Marine Mammal Notice

Collection of Eagle Feathers and Marine Mammal Parts

Protection of Cultural Resources

Instruction for the Disposition of Dead and Live Wildlife

Marine Mammal Notice

(Developed by NOAA in 1989 during the *Exxon Valdez* oil spill.)

To reduce stress caused by unnecessary disturbance to marine mammal haulouts and improve the changes for wildlife survival, an aircraft advisory is issued for coastal areas affected by the spill. These advisories request that pilots stay at least one-half mile offshore and 1000 feet above ground level from areas of wildlife concentrations and critical habitats. These areas are shown on maps and distributed to pilots. The most critical areas to avoid are: (list critical areas).

No person, except an authorized government official, will approach, molest, or take a seal or sea lion, regardless of whether the animal is oiled, distressed, lethargic, or abandoned. This reminder is necessitated by the widespread activities of oil spill cleanup personnel in areas where seals and sea lions are giving birth to pups. Although casual and distant human/marine mammal interactions may not always be avoidable, they are, to varying degrees, harmful to the animal. The following explanation and guidance with respect to seal pups is offered in the interest of avoiding law violations and minimizing human-induced mortality among marine mammals.

Live seal pups are to be left undisturbed, whether or not they have oil on them. A pup not accompanied by an adult and/or appearing emaciated may not be abandoned. Females commonly leave their pups alone for extended periods during foraging trips. Newborn and young pups appear emaciated before acquiring fat through nursing. It is not possible to distinguish between a normal pup and one that is truly distressed. In the presence of humans, female seals may only approach their pups at night to nurse them, making determination of abandonment difficult to establish. True abandonment is unlikely, barring death or serious injury to the mother.

Pup deaths will greatly increase if oiled animals are picked up and subjected to the stress of handling, transport, and rehabilitation centers. Unlike sea otters and birds, external oiling does not adversely affect a seal's heat conservation ability or indicate a need for human assistance. Persons finding seals, sea lions, whales, or porpoises that appear to be in distress should contact NOAA Fisheries. Do not touch or closely approach these animals.

Collection of Eagle Feathers and Marine Mammal Parts

In response to inquiries about collecting eagle feathers and marine mammal parts by personnel involved in cleanup activities during a spill, the laws and regulations dealing with the collection and possession of such materials are summarized below.

Collection of Eagle Feathers: The Eagle Act (Public Law 95-616, 92 Stat. 3114, 16 U.S. Code 668) *prohibits* the collection and possession of any eagle parts, including feathers.

Collection of Marine Mammal Parts: The Marine Mammal Protection Act of 1972 (Public Law 92-522, 88 State. 1027, 95 Stat. 979, 16 USC 1372) generally prohibits the collection and possession of any marine mammal parts. Under 50 CFR 18.26, the collection of certain dead marine mammal parts is allowed, as follows:

a. Any bones, teeth or ivory of any (non-endangered) dead marine mammal may be collected from a beach or from land within 1/4 of a mile of the ocean. The term "ocean" includes bays and estuaries.
b. Marine mammal parts so collected may be retained if registered within 30 days with an agent of the National Marine Fisheries Service, or an agent of the U.S. Fish and Wildlife Service.
c. Registration shall include (1) the name of the owner, (2) a description of the article to be registered, and (3) the date and location of collection. Items so collected and registered must be retained in the ownership of the collector. *The sale of such items is prohibited.*

Protection of Cultural Resources

Shoreline cleanup operations have the potential for damaging important archaeological and cultural resources. Authorized shoreline cleanup procedures may uncover undiscovered archaeological features or artifacts. To assist in their identification, drawings of the types of artifacts that might be found in the intertidal zone and along the shoreline by cleanup crews are included. Cleanup personnel should be aware of the policy that anyone found vandalizing or appropriating cultural materials will be subject to full prosecution under the Archaeological Resources Protection Act. If response personnel find any cultural resources (fossils, archaeological or historical artifacts), the following steps should be taken immediately:

1. Leave the cultural materials in place at the site of discovery and mark with flagging tape.
2. Stop cleanup activities in the surrounding area.
3. Inform a designated state representative.

Instruction for the Disposition of Dead and Live Wildlife

(Derived from the Wildlife Protection Guidelines, Alaska RRT 1991)

Dead Animals

1. Collect all dead animals (except whale and other large forms), including scavenged carcasses, to discourage further scavenging in oiled areas.
2. Wear gloves when handling dead animals.
3. Use a shovel or spade to uncover and remove carcasses partially covered by sand, wood, or other debris.
4. Place carcasses in double plastic garbage bags. Place all animals from one beach in one bag, if possible. Close securely with masking tape.
5. Complete an animal collection form or provide the following information:
   - beach name or location where carcasses were recovered
   - date
   - name and address of collector
   - species, age, and sex of collected animals .

   If any of this information is not available or questionable, this fact should be recorded so that additional examinations of the animals can be conducted.
6. Place the form or list in a ziplock baggie and place the baggie outside the first garbage bag but inside the second. Bring the dead animals to a designated recovery site

Live Animals

Authorization for animal rescue must be given by the appropriate State or Federal agency prior to the rescue and rehabilitation of oiled wildlife. Long-handled nets, rags, or towels are recommended for capturing live, oiled birds. Wear gloves to keep from getting oiled. Do not wash oiled birds. It is more important to keep them warm. Place them in a covered cardboard box. It is okay to keep more than one bird and multiple species in the same box. Do not attempt to give birds fluids; they should be taken to a rehabilitation center as soon as possible. For live birds, the following information should be reported:

- beach name or location where animal was recovered
- date and name and address of collector
- species, age, and sex of collected animals
- condition of the animal

Do not attempt capture of live sea otters without prior authorization from the appropriate agency. Inexperienced people can cause otters additional injuries. In addition, otters may bite and cause infections. A bite from an otter may result in inflammation of the joints and inability to bend one's fingers. Live, oiled otters are to be reported to the designated agency contact for the spill.

Appendix C

NOAA Scientific Support Coordinators

For more information about developing and applying shoreline countermeasures, contact the appropriate NOAA Scientific Support Coordinator for your area.

District	Address	Phone
1 Stephen Lehmann	NOAA SSC HAZMAT First CG District (mer) 408 Atlantic Avenue Boston, MA 02110	(w) 617-223-8016 (fax) 617-439-0468
1/5 Ed Levine	NOAA SSC HAZMAT Building 100, Box 2 Governors Island New York, NY 10004-5000	(w) 212-668-6428 (fax) 212-668-6370
2/9 Ken Barton	NOAA SSC HAZMAT c/o USCG Marine Safety Division AJC Federal Building 1240 E. Ninth Street Cleveland, OH 44199	(w) 216-522-7760 (fax) 216-522-7759
5 Gary Ott	NOAA SSC HAZMAT USCG RTC Yorktown (t-mer) Yorktown, VA 23690-5000	(w) 804-898-2320 (fax) 804-898-2296
7 Brad Benggio	NOAA SSC HAZMAT Miami Federal Build Rm 1119 51 S.W. First Ave, PO Box 83 Miami, FL 33130	(w) 305-530-7931 (fax)305-530-7932
8 Mike Barnhill	NOAA SSC HAZMAT Cdr Eighth CG District (m-ssc) Hale Boggs Federal Bldg 500 Camp Street New Orleans, LA 70130-3396	(w) 504-589-6901 (fax)504-589-4999
11 Jim Morris	NOAA SSC HAZMAT 501 West Ocean Blvd. Rm 5110	(w) 310-980-4107 (fax) 310-980-4109 Long Beach, CA 90802

13/14 Sharon Christopherson	NOAA / HAZMAT 7600 Sand Point Way N.E. Seattle, WA 98115-0070	(w) 206-526-6829 (fax) 206-526-6329
District	**Address**	**Phone**
17 John Whitney	NOAA SSC HAZMAT Peterson Towers Bldg 510 L Street, Ste #100 Anchorage, AK 99501	(w) 907-271-3593 (fax) 907-271-3139

Glossary

Aerobic

Able to live or grow only where air or free oxygen is present.

*A*naerobic

Able to live and grow where there is no air or free oxygen.

Annual

A plant that lives only one year or season.

Aromatic

Organic compounds containing any of a series of benzene ring compounds. They are unsaturated organic ring compounds with low to high boiling points. The lighter components are generally acutely toxic to aquatic life.

Benthos

The plants and animals that live in and on the bottom of a water body.

Berm

A wedge-shaped sediment mass built up along the shoreline by wave action. Sand berms typically have a relatively steep seaward face (beach face) and a gently sloping surface (berm top). A sharp crest (berm crest) usually separates the two oppositely sloping planar surfaces on top of the berm. Berms on sand beaches are eroded away during storms, thus a berm may not be present if the beach is visited shortly after a storm. On gravel beaches, however, steep and high storm berms are activated and refurbished during storms.

Biota

Animal and plant life characterizing a given region. Flora and fauna, collectively.

Booms

Both containment and absorbent booms are used for the collection, deflection, and containment of spreading oil. Containment booms are somewhat rigid structures extending both above and below the water acting as barriers to surface oil. Primary containment

booms are usually deployed close to oiled shorelines to trap oil being flushed from beaches before it is collected. Secondary containment booms are deployed farther out to trap oil that leaks past primary booms. Absorbent boom is used along the shore-water interface to collect oil dislodged during treatment operations. It is important that sorbent boom be changed once the sorbent capacity is reached. Great care should be taken to seal the shore ends of booms so that no oil can get past. This is particularly difficult at rocky shorelines, or areas strewn with boulders and cobbles. The use of sorbent pads or other materials, such as "pom poms," can be effective sealants.

Brackish

Intermediate in salinity (0.50 to 17.00 parts per thousand) between sea water and fresh water.

Dispersant

Chemical agent used to disperse and suspend oil in water leading to enhanced dispersal and biodegradation.

Emulsification

The process by which oil is mixed with water.

Erosion

The wearing away by action of water or wind on unprotected or exposed earth.

Estuary

Classic definition A drowned river valley that has a significant influx of fresh water and is affected by the tides. Most of the coastal water bodies in the mid-Atlantic region are estuaries (e.g., Chesapeake Bay, Delaware Bay).

Evaporation

The conversion of a fluid—including hydrocarbons—to a gaseous state.

Fertilizer

A substance or agent that helps promote plant or seed growth.

Flushing

Use of a water stream to make oil flow to a desired location or recovery device.

Habitat

The chemical, physical, and biological setting in which a plant or animal lives.

Intertidal

The part of the shoreline that lies between high-tide and low-tide water levels.

Lagoon

A shallow, linear, and usually oblong water body, located parallel with and connected to a larger water body by one or more inlet channels.

Marsh fringe

The edge of the marsh adjacent to the water.

Mobile oil

Oil that can refloat when water is applied (as in high tide).

Mousse

A type of oil / water emulsion which can contain up to 70 percent water.

Non-persistent

Decomposed rapidly by environmental action.

Oleophilic

A material that has affinity for oil.

Penetration

Downward motion of oil into sediments from the surface driven by gravitational forces.

Perennial

Vegetation that continues to grow for several years.

Permeability

The degree to which fluids can flow through a substance. Measured in Darcys. Permeability is not equal to porosity. High porosity of a material does not insure high permeability. A substance cannot be permeable without having some degree of porosity.

Pooled oil

Oil thickness exceeds one centimeter. This need not be uniform.

Porosity

The volume of void spaces in a sediment mass, measured in percent.

Riprap

(a) A layer of large, durable fragments of broken rock, specially selected and graded, and thrown together irregularly or fitted together. Its purpose is to prevent erosion by waves or currents and thereby preserve the shape of a surface, slope, or underlying structure. It is used for irrigation channels, river-improvement works, and revetments for shore protection.

Recontamination

Contamination by oil of an area that was previously cleaned.

Rhizome

A rootlike stem under or along the ground, ordinarily in a horizontal position, which usually sends out roots from its lower surface and leafy shoots from its upper surface.

Skimmer

A mechanical device that removes an oil film from the water surface.

Oil skimmers collect oil spilled on, or released to, the water's surface. They come in a wide range of shapes and sizes. Skimmers generally have a higher recovery rate than sorbents, providing enough oil is present to justify the costs for its use. Skimmers are usually equipped with storage space for collected oil. Oil is herded to a collection point along a containment boom located close to shore yet in water of sufficient depth for the skimmer to function. Two types of skimmers currently in use are described below. Other types of skimmers are being tested for possible use at a later date.

> Band, or "rope," skimmers use an oleophilic material such as polypropylene. Oil is collected by a floating, continuous rotating band or "rope" drawn through an oil slick or along the water's edge of a contaminated area. Adhered oil is wrung from the band by a squeeze roller and collected in an oil sump. These bands are used in either static

(stationary) or dynamic (towed) modes. Bands can be torn by solids or skimmed debris. Efficiency is high in calm waters, poor in choppy waters and waves.

Belt skimmers use an oleophilic belt mounted on the front of a small vessel. The oleophilic belt pushes the floating oil below the waterline. Oil not adsorbed by the belt is collected into a holding area located behind the belt. Oil carried up the belt is recovered at the top of the system by a squeeze belt or scraper blade. It is then pumped into a storage container. These skimmers can not operate in shallow waters or tight areas.

Slurry

A suspension of particles in water.

Solubility

The amount or fraction of a substance (e.g., oil) that dissolves into the water column, measured in ppm.

Solvent

A chemical agent that will dissolve oil.

Specific gravity

The measure of the density of a substance such as oil or sea water, usually determined at 20°C, compared to the density of pure water at 4°C. Thus, specific gravity varies slightly with temperature.

Sorbent

All sorbent materials work on the same principles—oil adheres to the outside of the material or sorbs into the material by capillary action. There are three basic types of sorbent materials: mineral based, natural organic, and synthetic organic. Currently, only synthetic organic sorbents are being used in the field in the form of booms, pads, and mops. Peat is currently in the testing and demonstration phase.

Stain

Oil that is visibly present but cannot be scraped off with a fingernail.

Substrate

The substance, base, or nutrient on which, or the medium in which, an organism lives and grows, or the surface to which a fixed organism is attached; e.g., soil, rocks, and water.

Subtidal

That part of the coastal zone that lies below the lowest low-tide level, so that it is always underwater.

Supratidal

Above the normal high-tide line.

Tarballs

Lumps of oil (<10 cm in diameter) weathered to a high density semisolid state.

Toxicity

The inherent potential or capacity of a material (e.g., oil) to cause adverse effects in a living organism (Rand and Petrocelli, 1985).

Viscosity

Flow resistance; referring to internal friction of a substance (e.g., oil) that is a function of the oil type and temperature.

Vacuum systems

Used to recover oil collected behind containment booms along the beach face and in the water during shoreline flushing operations. Where equipment access allows, vacuums can be used to remove pools of oil directly from shorelines and surfaces of heavily oiled rocks. Two vacuum systems currently in use are described below.

> The first system is classified as a vacuum device, but requires a high-velocity air stream, @ 150 mph, to draw oil, water, and debris into the unit's collection chamber. Due to the 6- to 12-inch diameter of the inlet hose, it rarely becomes clogged by debris. The inlet nozzle should always be placed slightly above (never below) the fluid's surface. The distance at which it is held above the fluid is critical to limit the amount of water intake. This system is suitable for picking up weathered oil, tar balls, and mousse from water or shorelines, and to vacuum oil from skimming vessels, boomed areas, or debris-laden sites. The primary advantage is its ability to pick up oil of any viscosity and, where necessary, lift fluid more than 30 feet. The system can pick up

and decant simultaneously. The main disadvantages are that it usually picks up a high water/oil ratio, and can be difficult to repair in the field.

The second system, barge-mounted vacuum trucks, use high-suction pumps and a cylindrical chamber capable of sustaining very low internal pressure, i.e., minus 12 psi. Vacuum is created in the chamber, and a 3- to 4-inch diameter hose is usually placed slightly below the surface of a floating oil slick, allowing a mixture of water and oil to enter the collection chamber. The position of the open end of the vacuum hose is critical. If it is placed too far down into the oil slick, recovered fluid will be mostly water; if not deep enough, air will be sucked into the system, and much of the vacuum will be lost. The primary advantages of the vacuum truck system are: it can recover fluid of nearly any viscosity; it has a rapid pickup rate of thick oil layers; and it can recover a wide variety of small debris. Primary disadvantages are its limited lift, no more than 20 to 30 feet, and the length of time required to reestablish a vacuum if air enters the hose. As with the other vacuum, this one also picks up a high water/oil ratio.

Weathering

Natural influences such as temperature, wind, and bacteria that alter the physical and chemical properties of oil.

Weir

A vertical barrier placed just below the surface of the water so that a floating oil slick can flow over the top.

Wetlands (as defined by the Annotated Code of Maryland Title 9)

State wetlands: Lands below the mean high-tide line affected by the regular rise of tide.
Private wetlands: Lands bordering on state tidal wetlands, below the mean tide line subject to the effects of the regular rise and fall of tide. Lands able to support growth of wetland vegetation.

Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, and is at least periodically saturated with or covered by water (Cowardin et al. 1979).

Wrack

Accumulations of plant debris that is deposited at or above the high-tide line (e.g., *Spartina* or seagrass debris).

Bibliography

American Petroleum Institute. 1982. *Oil Spill Response: Options For Minimizing Adverse Ecological Impacts*. Publication No. 4398. Washington, D.C.: American Petroleum Institute. 98 pp.

Bobra, M., P. Kawamura, M. Fingas, and D. Velicogna. 1987. Laboratory and mesoscale testing of Elastol and Brand M demoussifer. *Proceedings of the 10th Arctic and Marine Oil Spill Program Technical Seminar, June 9-11, 1987.* Edmonton, Alberta, Canada. pp. 223-241.

Breuel, A. 1981. *Oil Spill Cleanup and Protection Techniques for Shorelines and Marshlands.* Park Ridge, New Jersey: Noyes Data Corp. 404 pp.

Cairns, J., Jr. and A.L. Buikema, Jr. (Eds.). 1984. *Restoration of Habitats Impacted by Oil Spills.* Boston: Butterworth Publishers.

CONCAWE. 1987. *A Field Guide To Coastal Oil Spill Control And Clean-up Techniques.* The Hague, The Netherlands. 112 pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. *Classification of wetlands and deepwater habitats of the United States.* Washington, D.C.: U.S. Fish and Wildlife Service. 103 pp.

Environment Canada. 1992. *Oilspill SCAT Manual for the Coastlines of British Columbia.* Edmonton, Alberta, Canada: Technology Development Branch, Conservation and Protection. 245 pp.

DOI. 1991. Wildlife Protection Guideline for Alaska. Tab D to Annex X of the Alaska Region Oil and Hazardous Substances Pollution Contingency Plan. Anchorage: U.S. Department of the Interior. 229 pp.

ERCE and PENTEC. 1991. *Evaluation of the condition of intertidal and shallow subtidal biota in Prince William Sound following the Exxon Valdez oil spill and subsequent shoreline treatment.* Report HMRAD 91-1. Seattle: Hazardous Materials Response and Assessment Division, National Oceanic and Atmospheric Administration. Two Volumes.

Fiocco, R.J., G.P. Canevari, J.B. Wilkinson, J. Bock, M. Robbins, H.O. Jahns, and R.K. Markarian. 1991. Development of Corexit 9580–A chemical beach cleaner. *Proceedings of the 1991 International Oil Spill Conference, March 4-7, 1991, San Diego, California.* API Publication No. 4529, Washington, D.C.: American Petroleum Institute, pp. 395-400.

Hayes, M.O., E.R. Gundlach, and C.D. Getter. 1980. Sensitivity ranking of energy port shorelines. *Proceedings of the Specialty Conference on Ports '80, May 19-20, 1980, Norfolk, Virginia,* pp. 697-708.

Hayes, M.O., J. Michel, and B. Fichaut. 1991. Oiled gravel beaches: A special problem. *Proceedings of the Specialty Conference on Oil Spills, Management and Legislative Implications,* published by American Society of Civil Engineers pp. 444-457.

Interagency Shoreline Cleanup Committee. 1989. *Field Shoreline Treatment Manual.* Valdez, Alaska: National Oceanic and Atmospheric Administration, Alaska Department of Environmental Conservation, Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, and Exxon.

Meyers & Associates and RPI, Inc. 1989. *Oil Spill Response Guide.* Park Ridge, New Jersey: Noyes Data Corp. 314 pp.

National Research Council. 1989. *Using Oil Spill Dispersants on the Sea.* Washington, D.C.: National Academy Press. 335 pp.

National Oceanic and Atmospheric Administration. 1992. *Introduction to coastal habitats and biological resources for oil spill response.* Report HMRAD 92-4. Seattle: Hazardous Materials Response and Assessment Division, NOAA. 384 pp.

Nauman, S.A. 1991. Shoreline Cleanup: Equipment and Operations. *Proceedings of the 1991 International Oil Spill Conference, March 4-7, 1991, San Diego, California.* Washington, D.C.: American Petroleum Institute. pp. 1411-1417.

Owens, E.H. and A.R. Teal. 1990. Shoreline cleanup following the *Exxon Valdez* oil spill–field data collection within the SCAT program. *Proceedings of the 13th Arctic and Marine Oil Spill Program Technical Seminar, June 6-8, 1990, Edmonton, Alberta, Canada,* pp. 411-421.

Prince, R.C., J.R. Clark, and J.E. Linstrom. 1990. *Bioremediation Monitoring Program*. Anchorage: Exxon, U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation. 85 pp. plus appendices.

Rand, G. M. and S. R. Petrocelli. 1985. *Fundamentals of Aquatic Toxicology*. Washington, D.C.: Hemisphere Publishing Company. 666 pp.

Virginia Institute of Marine Science. 1983a. *ESI Atlas of Maryland.* Seattle: Hazardous Materials Response and Assessment Division, National Oceanic and Atmospheric Administration. 119 maps.

Virginia Institute of Marine Science. 1983b. *ESI Atlas of Virginia.* Seattle: Hazardous Materials Response and Assessment Division, National Oceanic and Atmospheric Administration. 113 maps.

Virginia Institute of Marine Science. 1983c. *ESI Atlas of North Carolina.* Seattle: Hazardous Materials Response and Assessment Division, National Oceanic and Atmospheric Administration. 113 maps.

Sanders, N. and E. Gray. *Alaska Oil Spill Bioremediation Project Workshop Summary*. Rockville, Maryland: Technical Resources, Inc. 8 pp.

Tetra Tech. 1982. *Ecological Impacts of Oil Spill Cleanup: Review and Recommendations.* Draft report. Washington, D.C.: American Petroleum Institute.

U.S. Congress, Office of Technology Assessment. 1991. *Bioremediation for Marine Oil Spills - Background Paper*. OTA-BP-0-70. Washington, D.C.: U.S. Government Printing Office. 31 pp.